DOCUMENT RESUME

ED 383 562 SE 056 386

| | |
|---|---|
| TITLE | Taking a Closer Look at Science. Science Diagnostic Procedure. Education 5-14. |
| INSTITUTION | Scottish Council for Research in Education, Edinburgh. |
| REPORT NO | ISBN-1-86003-002-5 |
| PUB DATE | 95 |
| NOTE | 59p.; The materials were developed with funding from the Scottish Office Education Department and the Scottish Council for Research in Education. |
| AVAILABLE FROM | Scottish Council for Research in Education, 15 St. John St., Edinburgh EH8 8JR, Scotland, United Kingdom. |
| PUB TYPE | Guides - Classroom Use - Teaching Guides (For Teacher) (052) -- Guides - Non-Classroom Use (055) |
| EDRS PRICE | MF01 Plus Postage. PC Not Available from EDRS. |
| DESCRIPTORS | Administrator Guides; *Curriculum Based Assessment; *Curriculum Development; Educational Testing; Elementary Secondary Education; *Evaluation Methods; Foreign Countries; *Science Curriculum; Science Education; Teaching Guides |
| IDENTIFIERS | Scotland |

ABSTRACT

This diagnostic assessment guide is designed to assist schools in developing their curriculum and assessment policies and help teachers in assessing individual pupils' understanding and progress and identifying appropriate next steps in a way which fits in with day to day teaching. Existing research and practice are applied within the context of curriculum and assessment for Education 5-14. The principles of diagnostic assessment and the procedures for putting them into practice in science are illustrated by reference to work in primary classes. However, the principles are equally applicable to work carried out in secondary schools. The eight chapters are: (1) introduction; (2) science context, particularly the key role of investigation skills; (3) how to collect information; (4) implementing diagnostic assessment as part of teaching; (5) ways of gathering information through observation, discussion, questioning and analyzing pupils' work; (6) ways of considering pupils' work using attainment targets; (7) strategies for helping pupils develop further understanding and skills in science; and (8) how the processes and products of pupils' work can be assessed in terms of the criteria of the attainment targets for Environmental Studies 5-14. (LZ)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED 383 562

# TAKING *a closer look* at SCIENCE

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN **OTHER THAN PAPER COPY** HAS BEEN GRANTED BY

R. WAKE

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SCO50200

BEST COPY AVAILABLE



SCRE
The Scottish Council for Research in Education

Education 5–14

Science

Diagnostic Procedures

# *Taking a Closer Look at Science*

SCRE

The Scottish Council for Research in Education

SCRE Publication 127 (Science Pack)

ISBN 1 86003 002 5

© The Scottish Council for Research in Education

First published 1995

***The 'Taking a Closer Look'*** series

The series consists of sets of publications for English language, maths, and science.

**Introductory booklet.**

- *Key Ideas in Diagnostic Assessment: An Introduction to the Taking a Closer Look Series.* Revised edition (1995).

**English Language.** A package containing –

- *Taking a Closer Look at Reading* (1995). Teacher's guide.
- *Taking a Closer Look at Writing* (1995). Teacher's guide.
- The introductory booklet *Key Ideas.*

**Mathematics.**

*Set 1:* A package containing –

- *Taking a Closer Look at Shape, Position and Movement/Problem Solving: Space, Fact and Fiction* (1993). Pupil worksheets and teacher's notes and teacher's guide.
- The introductory booklet *Key Ideas.*

*Set 2:* A package containing –

- *Taking a Closer Look at Shape, Position and Movement/Problem Solving: Around Town* (1993). Pupil worksheets and teacher's notes.

*Set 3:* A package containing –

- *Taking a Closer Look at Number* (1995). Teacher's guide.
- *Taking a Closer Look at Information Handling* (1995). Teacher's guide.
- The introductory booklet *Key Ideas.*

**Science.** A package containing –

- *Taking a Closer Look at Science* (1995). Teacher's guide.
- The introductory booklet *Key Ideas.*

Published by the Scottish Council for Research in Education, 15 St John Street, Edinburgh EH8 8JR.
Printed by GNP Booth, Glasgow.

# Contents


1 Introduction ..... 1
- What the guide contains ..... 1

2 Learning in Science ..... 3
- The development of ideas ..... 3
- The importance of process skills ..... 4
- The role of attitudes ..... 4
- The context for diagnostic assessment ..... 5

3 The Practicalities of Collecting Information ..... 6
- Assessing skills and attitudes ..... 6
- Assessing specific knowledge ..... 6

4 General Procedures ..... 7
- The opportunities needed ..... 7

5 Gathering Evidence ..... 10
- Evidence from observation ..... 10
- Collecting products ..... 11
- Oral questioning ..... 11
- Setting tasks or assignments ..... 12

6 Interpreting Evidence ..... 14
- Agreed criteria ..... 14
- Linking criteria to pupils' work ..... 14

7 Advancing Pupils' Ideas and Skills ..... 15
- Helping the development of skills and attitudes ..... 15
- Helping the development of ideas ..... 17

8 Examples of Diagnostic Procedures in Action ..... 19
- Investigation skills (Examples 1 to 5) ..... 20
- Knowledge and understanding (Examples 6 to 25) ..... 32


BEST COPY AVAILABLE

# Acknowledgements

This document is one of a series arising from work funded by the Scottish Office Education Department and the Scottish Council for Research in Education. The authors are grateful for the support of these bodies and for the assistance and insights provided by our advisory committee and by members of Her Majesty's Inspectorate of Schools.

The Diagnostic Procedures project comprised work in English language, mathematics and science. None of it would have been possible without the co-operation of all those teachers who were willing to allow us into their classrooms and to take up their time, or who provided valuable comments on the draft materials. Special thanks are also due to the pupils who allowed themselves to be observed, questioned and taped as they worked in their classrooms. We are grateful to Information Services at SCRE for the prompt and efficient way in which they helped with the initial search of the very extensive research literature and, later, edited and undertook the presentation of the text. Particular thanks are also due to Catherine Hart, Jennie Jackson and Kay Young for their secretarial support and forbearance.

The main authors of the packages are: John Hall and Louise Hayward (English Language); Marion Devine and Myra Pearson (Mathematics); Wynne Harlen, Iain Smithers and Carole Thomson (Science).

The project was directed by Harry Black, depute director of SCRE. Harry's thoughtful leadership and stimulating criticism contributed immeasurably to the project. His sudden death in June 1994 shocked us all. He will be greatly missed.

*Project team and advisory committee*
Roger Williams, Lothian Region (Chair of Advisory Committee)
Harry Black, The Scottish Council for Research in Education
Marion Devine, The Scottish Council for Research in Education
Michael Gibson, HMI Scottish Office Education Department
John Hall, The Scottish Council for Research in Education
Wynne Harlen, The Scottish Council for Research in Education
Louise Hayward, St Andrew's College of Education
Ian MacAskill, HMI Scottish Office Education Department
Sue Mingard, The Scottish Council for Research in Education
Myra Pearson, University of Strathclyde, Faculty of Education
Iain Smithers, Northern College (to June 1992)
Ernie Spencer, HMI Scottish Office Education Department
Carole Thomson, Northern College (from September 1992)

BEST COPY AVAILABLE

# 1 Introduction

This package offers help with the assessment of learning in science in a way which fits into normal teaching. It is concerned with the kind of assessment which is an essential part of teaching because it identifies not only where pupils are in their development of skills and of knowledge and understanding but also indicates what next steps need to be taken.

The principles of diagnostic assessment and the procedures for putting them into practice in science are illustrated in this package by reference to work of primary classes. However the principles are equally applicable to work carried out in secondary schools.

Assessment can take many forms and can fulfil many purposes. This booklet is about some of those forms of assessment but it is focused on one purpose: to help teachers to teach and pupils to learn. The context is classrooms where teachers are implementing a curriculum based on the 5–14 guidelines.

The national guidelines on *Assessment 5–14* and, in particular, the staff development pack *From Guidelines to Policy and Practice*, set assessment firmly in the context of learning and teaching. A number of clear principles are established for effective learning, teaching and assessment:

- teachers should be clear about learning aims for individuals, groups and classes, taking into account what has gone before
- teachers should build upon pupils' current strengths and weaknesses
- teachers should share their aims with pupils and, when possible, parents
- assessment should be carefully managed
- assessment should be based on carefully chosen evidence
- information from assessment should be shared with the pupils to help determine next steps
- next steps identified for pupils should be both challenging and attainable
- teachers are recognised as the single most important influence in ensuring quality.

*WHAT THE GUIDE CONTAINS:*

Chapter 1 (Introduction)

Chapter 2 (Learning in science) discusses the science context, particularly the key role of investigational skills in the development of scientific understanding and the role of diagnostic assessment in helping learning.

Chapter 3 (The practicalities of collecting information) – how to collect information in the course of normal classroom teaching.

Chapter 4 (General procedures) makes suggestions for implementing diagnostic assessment as part of teaching. It includes a diagrammatic overview of how the general procedures might operate.

Chapter 5 (Gathering evidence) focuses on ways of gathering information through observation, discussion, questioning and analysing pupils' work.

Chapter 6 (Interpreting evidence) looks at ways of considering pupils' work using attainment targets, as an introduction to the examples of pupils' work section.

Chapter 7 (Advancing pupils' ideas and skills) outlines strategies which teachers can use to help pupils develop further understanding and skills in science.

Chapter 8 (Examples of diagnostic procedures in action) illustrates how the processes and products of pupils' work can be assessed in terms of the criteria of the attainment targets for *Environmental Studies 5–14*.

Reference is made in the text to the following publications relating to the Education 5–14 programme:

Scottish Office Education Department (1991) *Assessment 5–14. Curriculum and Assessment in Scotland, National Guidelines.* Scottish Office Education Department.

Scottish Office Education Department (1991) *Environmental Studies 5–14. Curriculum and Assessment in Scotland, National Guidelines.* Scottish Office Education Department.

Scottish Office Education Department (1990) *Assessment 5–14. Part 3, From Guidelines to Policy and Practice: a staff development pack. Curriculum and Assessment in Scotland, National Guidelines.* Scottish Office Education Department.

# 2 Learning in science

The three main aspects of learning science are:

- developing knowledge and understanding
- developing skills of investigation
- developing attitudes.

Although these are discussed here separately (as they are in the *Environmental Studies 5–14 Guidelines*) they cannot be taught separately because they are closely dependent on each other. On the one hand, knowledge and understanding depend on using skills and attitudes. On the other hand, skills and attitudes can only be developed in the context of particular subject matter and are affected by the knowledge and understanding of that subject matter. It is worth spending a little time on this relationship as it is so important in explaining why we must give attention to assessment of all three aspects above.

The learning that we are concerned with is far more than knowing facts and generalisations. It is the development of ideas and concepts. *Concepts* are generalisations which describe how certain features of things or events are related to each other. They are the result of abstracting features which objects or events have in common and of ignoring others; examples include temperature, density, energy. *Ideas* are the building blocks of concepts and, like concepts, help in making sense of facts which arise from our own or others' observations. Facts are important starting points for the development of ideas and concepts, but if learning goes no further than the acquisition of facts then it cannot be described as knowledge and understanding.

## *THE DEVELOPMENT OF IDEAS*

When faced with new experiences from which they can learn, children begin by trying to make sense of them using ideas formed from previous experience. This 'trying to make sense' (learning) involves using the process skills of observing, hypothesizing, predicting, planning, experimenting, interpreting and drawing conclusions. As a result it can be decided whether or not the initial ideas, or modifications of them, fit the evidence. If the ideas do fit, they are strengthened because they enable a greater range of experience to be understood. If the initial ideas don't at first fit, they may do so if modified to encompass a broader range of experiences. So, for example, in trying to decide if an object is living or not living or has once been alive, a child first uses his or her existing notion of the characteristics of 'living'. But if an object thought, on this basis, not to be living exhibits behaviour which contradicts the judgement, then the child's notion of 'living' is changed. (This happens when children change from regarding movement as the essential indicator of being alive towards a view which would include plants as being alive.) So learning is best seen as a change in ideas rather than a process of taking in formed ideas. Any new ideas which are learned by rote and do not link to previous thinking or experience are of very little use and cannot be said to be understood.

BEST COPY AVAILABLE

It follows that it is important for the teacher to be aware of the ideas the pupils are using to try to make sense of their experiences. With this knowledge, the teacher is in a far better position to help development towards a better understanding than if no effort is made to find out what the pupils already know and understand. There are two main reasons for this, one being the more obvious point that gaps and repetition can be avoided. The other is because existing ideas which are non-scientific ('misconceptions' as they have been called) can actively interfere with further learning. For example, pupils who believe that it is 'natural' for moving objects gradually to stop moving will be unreceptive to the search for forces which bring moving objects to rest. Thus teachers need to be aware of the existence of 'misconceptions' and take action to help pupils change their ideas.

The ideas we are concerned with in a particular activity are those relating to the science attainment outcomes of the *Environmental Studies 5–14 Guidelines*:

- Understanding Living Things and Processes of Life
- Understanding Energy and Forces
- Understanding Earth and Space.

## THE IMPORTANCE OF PROCESS SKILLS

In the description of development of ideas given above, the decision about whether or not an idea is judged as fitting the evidence depends on how the processes (the observing, interpreting, etc) are carried out. If this is not in a rigorous and scientific manner, then the ideas emerging from the investigation will not necessarily fit the evidence. Ideas may be accepted which ought to have been rejected, and vice versa. Thus, the development of ideas depends crucially on the processes used and how they are used.

It follows that attention needs to be given to the way in which pupils investigate and test out their ideas in science, that is, to the development of the skills expressed in the following strands of the *Environmental Studies 5–14 Guidelines*:

- planning
- collecting evidence
- recording and presenting
- interpreting and evaluating.

## THE ROLE OF ATTITUDES

It is important not to neglect development of positive attitudes in the aims of pupils' education in science. Attitudes tend to control willingness to undertake certain actions and in their more developed form become commitments to behave in certain ways, as in a commitment to care for the environment. Although progression in attitudes is not spelled out in the 5–14 guidelines in the degree of detail as are skills and concepts, it is nonetheless important to assess this and explicitly encourage development. Since progression in attitudes applies, rather in the same way as skills, to some extent to all activities, this will be included in the assessment procedures which are suggested for skills.

BEST COPY AVAILABLE

## THE CONTEXT FOR DIAGNOSTIC ASSESSMENT

The essence of science is developing understanding about the natural and built environment. This is true for the activity of scientists as much as for the activity of pupils learning science. However pupils have not built up the abstract concepts of science that scientists use: both their experience and their ways of thinking about it are necessarily limited. They are dependent for their learning in science on concrete, real experience of things in their environment, from which the more abstract ideas may eventually emerge.

So learning science must involve pupils in exploring, investigating and communicating about things in the world around them. To help this learning, diagnostic assessment must take place in these same contexts. The practical problems are obvious. So in the next chapters we consider the practicalities and then the procedures that have been developed through classroom trials and that teachers have found to work.

BEST COPY AVAILABLE

# 3 The practicalities of collecting information

Different aspects of achievement offer different assessment opportunities. For instance, unlike specific knowledge, many of the skills and attitudes which pupils should develop can be assessed in any investigation and therefore the opportunity to assess them will occur as frequently as pupils undertake investigations.

## ASSESSING SKILLS AND ATTITUDES

These can be called 'frequently occurring' aspects. They do not need to be assessed for all pupils every time they occur because there are many opportunities available. This is fortunate, because it would impose an unreasonable demand, given that, by the nature of the skills and attitudes, their assessment must include some observation on the spot.

The practicable strategy is for small groups of pupils to be the focus for the diagnostic assessment in a particular activity. All pupils will, in turn, be among those targeted. When their turn comes, the pupils will be unaware of having special attention from the teacher, who will continue to interact with all the pupils in the class as usual. However, when interacting with the pupils whose progress is being assessed, the teacher will question, probe, observe and keep records (at the time or soon after). Such rotas for attention are not uncommon (as in helping pupils with their reading) and imply no neglect of other pupils. In the case of science, the focus will be on the same few pupils throughout a particular investigation, which may spread over several teaching sessions. This may mean that it takes a term or more for all the pupils to have their turn. The pupils will be working on different investigations, on different topics and over a period of time. Does this matter? The answer is no when the purpose is to help their learning (but it would matter if the purpose were to assign a grade or label the pupils).

## ASSESSING SPECIFIC KNOWLEDGE

The opportunities for assessing specific parts of knowledge and understanding, however, do not occur as frequently as they do for skills and attitudes. Ideas relating to specific subject matter, such as magnetism or seed germination, can only be assessed when activities relate to these things.

These present 'infrequently occurring' opportunities for assessment. Information needs to be gathered about all the pupils working on a particular content whilst the opportunity exists. Fortunately these are aspects of achievement which can be assessed through class discussions or through pupils' reports of their work, their drawing and writing – things which can be studied after the event rather than assessed on the spot, so it is possible to collect information about several groups of children or even about a whole class during the time the relevant activities are in progress.

BEST COPY AVAILABLE

# 4 General procedures

The introductory booklet which accompanies the series, *Key Ideas in Diagnostic Assessment*, identifies four steps in using diagnostic assessment to explore pupils' progress and to help their learning. In relation to science these are:

Step 1: *deciding to take a closer look at progress* by providing opportunities for the skills and ideas to be used (this is covered in this chapter)

Step 2: *deciding how to gather evidence* about how skills and ideas are being used (in chapter 5)

Step 3: *appraising or interpreting the evidence* using the criteria indicating points in the pupils' progress (in chapter 6 and chapter 8)

Step 4: *exploring with pupils the action to take to help them forward* (in chapter 7).

The obvious, but most important, point to make is that, for assessment to be possible, pupils need the opportunity to carry out all parts of an investigation and to use the various process skills in developing their ideas about the subject matter. When we give pupils tests, the items present this opportunity and all pupils have the same chance to show what they can do (at least in theory). But here we are not talking about tests but about normal work in class and so this has to provide the opportunity for pupils to develop understanding and to use their investigational skills.

## *THE OPPORTUNITIES NEEDED*

Since the opportunities needed for diagnostic assessment are exactly the same as the opportunities for learning science, the assessment is not adding further demands. These opportunities are for pupils:

- to observe and explore events and materials relating to the topic in hand
- to put forward ideas that may help them in understanding their observations
- to plan in detail an investigation to test their ideas
- to decide how to ensure that the investigation is controlled and systematic ('fair')
- to carry out the investigation, making observations and measurements as appropriate
- to record information and results in suitable ways
- to interpret the results
- to attempt to explain the results and relate them to the original question
- to report the whole investigation in appropriate ways
- to reflect on the ideas emerging from the investigation and to apply them to the understanding of events in related contexts and problems.

Although there is a logical order in this list, the actions are not necessarily sequential in practice. For example, pupils will not always plan in detail before carrying out an investigation. Much planning happens as they go along and it is quite right that this should be so, since they cannot always anticipate the effect of one step in order to pre-plan the next one; they have to try it and see what happens. Similarly, pupils will be trying to explain their results as soon as they obtain them, without waiting to record and interpret them. Their teacher may choose to

question the pupils to encourage them to reflect upon and apply their ideas during the investigation as well as during the summing-up at the end.

The investigation of many questions provides for all these kinds of opportunities. For example, this is usually the case for investigations of the 'which is best?', or 'what happens if....?' or 'is there a connection between this and that?'

## TEACHER ACTIVITY

*Planning for teaching and assessment*

- Decide main ideas, skills and attitudes to be developed but leave details to be determined by pupils' ideas.
- Review corresponding parts of the 5 - 14 Environmental Studies guidelines.
- Reflect on pupils' previous experience and decide appropriate introduction and exploratory activities.
- Select group to be focus for close observation during practical work.
- Prepare the questions or other techniques to be used to explore pupils' existing ideas.
- Anticipate the help pupils may need in planning and carrying out their investigations.

*Introducing the topic: finding out about the pupils' ideas*

- Provide experiences which encourage pupils' open-ended exploration of the scientific aspects of the topic, eg
  - discussion of past experience
  - materials displayed
  - a visit, etc.
- Use open, pupil-centred questioning to elicit pupils' present understanding and ways of explaining things.
- Use real events, objects or materials to explore so that ideas are about specific things and shared experiences.
- Ask pupils how they would test their ideas.

*Deciding and planning investigations*

- Collect ideas from pupils and decide together which one(s) are to be investigated.
- Ask pupils for their ideas of how to go about the investigation, how to make sure it will give a fair result, how they will judge the result.
- Help pupils to plan details and to make a start. Young pupils may only be able to suggest what they will do to start with and then plan a step at a time. Older ones may be expected to respond to guidance through questions such as:
  - What will you change in order to test your idea?
  - What will you keep the same to make the investigation fair?
  - What will you look for or measure to find the results?
  - How will you do this?
  - What record will you make of the result?
- Ask the pupils to explain their plan, etc, giving them opportunity to re-think certain parts.

## PUPIL ACTIVITY

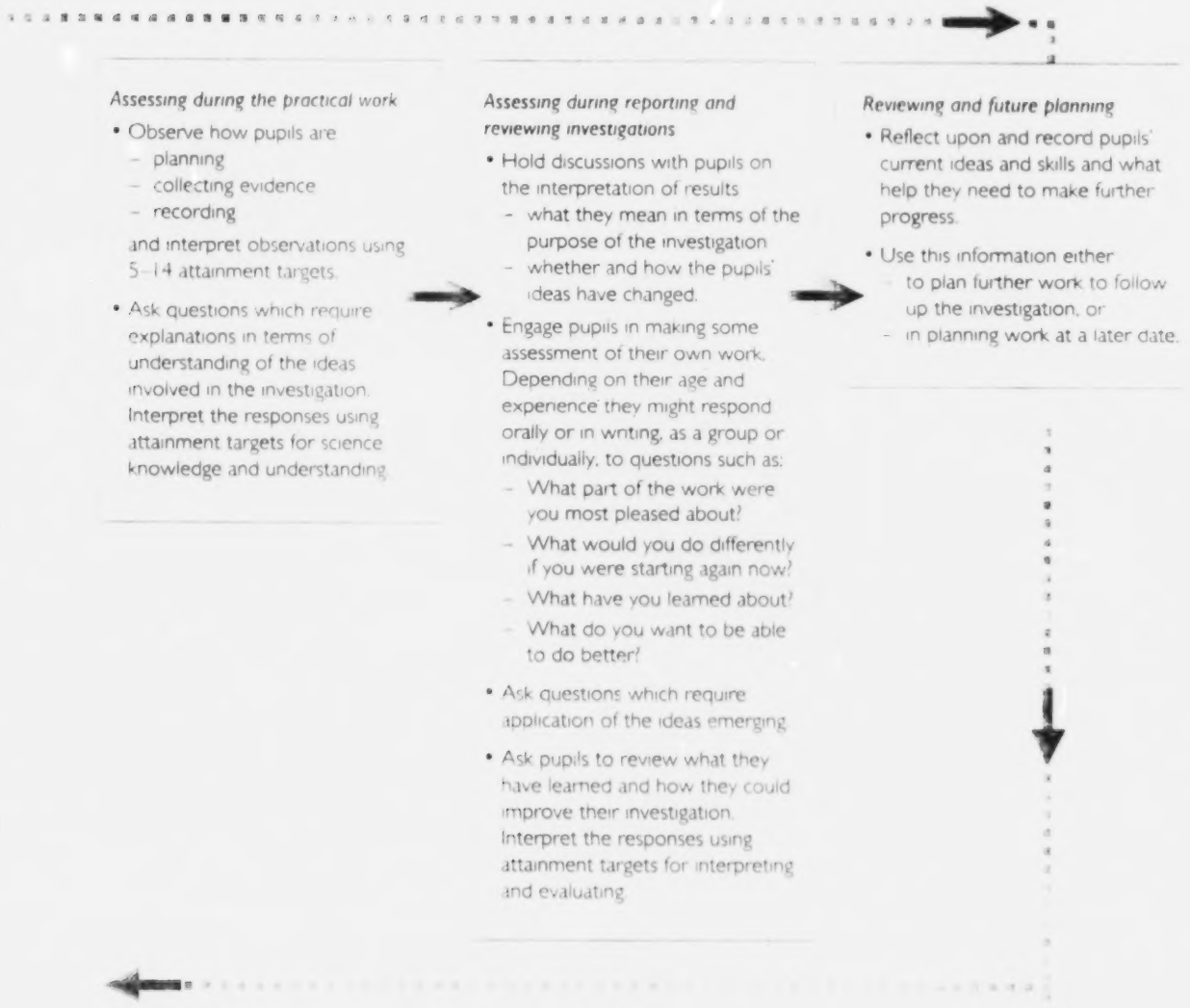
- Engage in exploration of materials/events/objects relating to the topic.
- Give ideas to explain observations.
- Suggest how ideas can be tested.

- Make suggestions for how to tackle the investigation.
- Plan the details either at the start or as they go along.
- Decide how to make the investigation fair.

BEST COPY AVAILABLE

kinds. But some investigations, such as those about simple electric circuits, do not give much opportunity for detailed observation or measurement. In such cases there would need to be opportunities provided in other investigations in order for pupils to develop these skills and thus for them to be assessed.

A schematic overview of the procedures is given below.


Assessing during the practical work
• Observe how pupils are
– planning
– collecting evidence
– recording
and interpret observations using 5–14 attainment targets.
• Ask questions which require explanations in terms of understanding of the ideas involved in the investigation. Interpret the responses using attainment targets for science knowledge and understanding.
Assessing during reporting and reviewing investigations
• Hold discussions with pupils on the interpretation of results
– what they mean in terms of the purpose of the investigation
– whether and how the pupils' ideas have changed.
• Engage pupils in making some assessment of their own work. Depending on their age and experience they might respond orally or in writing, as a group or individually, to questions such as:
– What part of the work were you most pleased about?
– What would you do differently if you were starting again now?
– What have you learned about?
– What do you want to be able to do better?
• Ask questions which require application of the ideas emerging.
• Ask pupils to review what they have learned and how they could improve their investigation. Interpret the responses using attainment targets for interpreting and evaluating.
Reviewing and future planning
• Reflect upon and record pupils' current ideas and skills and what help they need to make further progress.
• Use this information either
– to plan further work to follow up the investigation, or
– in planning work at a later date.
• Carry out the investigation, making observations and measurements.
• Record their results in suitable ways.
• Interpret their results
• Attempt to explain their results.
• Make a report of their work.
• Reflect upon and use ideas in other contexts to give oral or written answers.
• Take part in assessing their work.

BEST COPY AVAILABLE

# 5 Gathering evidence

The strategies most often used by teachers to take a closer look at pupils' progress in science are:

- looking more closely at evidence from classwork, for example by observation on the spot
- collecting products, such as reports, notes, drawings and graphs, and discussing these with the pupils
- asking oral questions of individuals and groups which probe understanding of ideas and process skills
- setting assessment tasks or assignments, for example asking for answers to questions which require pupils to apply scientific ideas.

The *Key Ideas* booklet outlines the general advantages and disadvantages of these strategies. Their use in science teaching is explored next.

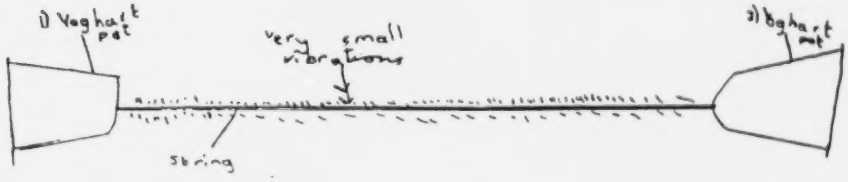
## *EVIDENCE FROM OBSERVATION*

Observation on the spot of pupils as they work is most often used to gather evidence of progress in the process skills pupils are using. It is useful to have some guidelines for focusing this observation so that information is gathered which can be interpreted in terms of the skill strands. These can be expressed in terms of questions for the teacher to have in mind (not to ask the pupils):

- How did the pupils identify the investigation?
  - what did they think they were finding out?
- How was the investigation set up to find this out?
  - what was varied?
  - what variables were kept the same?
- What was done to find the answer?
  - what was observed and how?
  - what was measured and how?
- What record was made, if any, of the results?
  - what notes were taken, diagrams drawn?
  - what tables, databases, were used to collect information?
- What conclusions were drawn and how?
  - how were data grouped, classified, compared?
  - were relationships identified?
  - was the original question answered?
- What explanations (hypotheses) were proposed to explain findings?
  - were alternatives suggested?
  - how were these evaluated/checked?
- What reports were made of the whole investigation?
  - did pupils co-operate in presenting their work to others?

## COLLECTING PRODUCTS

Almost all the pupils' writing, drawing or artefacts can be used as sources of information about their ideas and skills. These products are of particular value, however, if the tasks in which they are produced are expressed in certain ways. For example, in the following drawing of a 'string telephone', the pupil's explanation says a great deal about her understanding of the word 'vibration'. This is because her teacher deliberately asked her to use her drawing to explain how she thought the sound went from one yoghurt pot to the other. Had the teacher asked the pupil just to 'draw the yoghurt pot string telephone' it is likely that this information would not have been obtained.




The voice went to the string and were then transPered into vibrations which went down the string and when it got to the other yoghurt pot (2) and were then transPered back to a voice.

So, if drawing and writing tasks are given in terms such as 'make sure you explain how you think it works' and 'use labels to explain what the parts do, not just what they are' then the process is not only much more useful in making pupils reflect on their activities, but the products are also useful for assessing pupils' progress.

## ORAL QUESTIONING

It is important to ask oral questions which will encourage and enable pupils to express their ideas. Some kinds of questions are much better than others for this purpose. There are two aspects of questions to keep in mind: first, the form of the question; second, what is asked.

### *The form of question*

The form of question best for assessing pupil progress is open and pupil-centred:

*Open questions* invite an extended response as opposed to closed ones, to which there is a short or one-word answer. This means that questions to which the only answers are 'yes' or 'no' are very unlikely to be useful for the present purpose and should be avoided, for example:

*Ask:* What difference do you think it will make if the car starts higher up the slope?

*Instead of:* Will the car go further if it starts higher up the slope?

*Pupil-centred questions* ask deliberately for the pupils' ideas, not the 'right' answer. For the present purpose there is no 'right' answer, only the genuine ideas of the pupils. The way the question is phrased should convey this.

*Ask:* Why do you think that the cress in this soil grows better than in that soil?

*Rather than:* Why does the cress grow better in this soil than in that?

(The first shows interest in anything the pupil thinks about the problem, while the second asks for the answer. The pupil can always answer the first but not the second unless (s)he thinks (s)he knows the answer.)

What is asked in questioning to assess process skills (and attitudes) must reflect concern with pupils' ideas, not with what facts they know. The questions must delve into how pupils are making sense of something rather than what they know about it. The most useful questions will be ones which ask for explanations and those which ask for predictions. Both of these may be asked in relation to the current activity or asked to provoke application of ideas to other situations.

*Explanations* are often requested through 'why' questions, although in this context they should usually be 'why do you think' questions. The questions don't ask for facts or observations and indeed often state these to make this clear. For example:

*Ask* (after children have touched a piece of polystyrene and a piece of metal): Why do you think that the polystyrene feels warmer than the metal?

*Rather than*: Which of these is used to keep hot things hot?

*Questions asking for predictions* are useful in requiring pupils to apply their ideas: 'what do you think will happen if...?' or 'how could you make.... happen?' Asking for a prediction before the reason often helps pupils to reflect on their ideas. For example:

*Ask* (of pupils watching a damp hand print on a desktop slowly disappear): Is there anything which you could do that you think would make it disappear more quickly? Why do you think that would work?

## SETTING TASKS OR ASSIGNMENTS

Sometimes more structured written questions can be used to assess pupils' understanding through their ability to apply what they have learned to other situations. These questions should have the same characteristics as the oral questions discussed above. Some examples of application questions to which older pupils could give written answers are given below. Note that where a closed question is asked, this is followed by an open one asking for an explanation. In these cases what is important is the explanation given for a particular choice rather than whether the choice itself is acceptable.

1 Hot water tanks are usually wrapped in padded 'jackets' –

(a) Why do you think people do this?

(b) What do you think the padding does?

2 (a) If you wanted to keep a hot pie warm for as long as possible, which of these would you choose to wrap it in: metal foil; bin liner plastic; cardboard; a padded bag?

(b) Explain why you think the one you have chosen would be best.

1 (After pupils have observed some evaporation of water.)

(a) What do you think has happened to the water?

(b) What would you do to try to make it last for longer before disappearing? Why would this work?

(c) What would you do to try to make it disappear more quickly? Why would this work?



BEST COPY AVAILABLE

2 (a) Where would you put a painting you had just done to make it dry quickly?

(b) Why do you think this would work?

3 Draw a picture to show where you think the water goes when a puddle on the road dries up. Put labels on to explain what is happening.

About condensation

1 (After breathing onto a cold surface, such as a window pane until it is 'misted'.)

(a) What do you think has happened?

(b) Explain where you think the 'mist' has come from and why it has formed.

2 (After putting some pieces of ice in a glass or a tin in a warm room.)

(a) What do you think that is on the outside of the tin/glass?

(b) Where do you think it has come from and how did it get there?

About the growth of plants

1 Draw what you think is inside a seed before it begins to grow. Use labels to say what you think the various parts are for.

2 (a) What do you think a plant needs to keep it growing?

(b) Explain how you think it gets the things it needs.

[illegible]

1 (a) Why do you think that tigers and leopards have stripes and blotches on their coats?

(b) Can you think of any way in which the pattern on their coat might not be a help to them?

2 Brown bears are found in mountains in Canada and white bears in the Arctic.

(a) Try to think of two reasons we don't find white bears in the mountains and brown bears in the Arctic.

BEST COPY AVAILABLE

# 6 Interpreting evidence

The interpretation of pupils' actions, answers or products involves sifting through them to look for indications of the development of ideas, skills and attitudes. To do this it is necessary to have criteria in mind and most useful for teachers to use the same ones as each other.

## AGREED CRITERIA

The strands and attainment targets in the 5–14 guidelines suggest the aspects of performance which are significant in describing progress and provide criteria against which pupils' performance can be assessed.

Pupils' work can be analysed by:

- starting with the attainment targets and then looking for the aspects of work which fit one or more of them
- starting with the work and trying to match it to one or other of the targets.

In practice the best approach is a mixture of the two: to use selected targets to focus upon the relevant aspects of work, rather than trying to take everything into account; then to consider the chosen aspects in more detail, returning to the targets to find which provides the closest description.

## LINKING CRITERIA TO PUPILS' WORK

But the targets are expressed in general terms and it is sometimes difficult to know what they mean in relation to specific pieces of work. Examples help to link pupils' work to the various levels in the strands. The discussion of examples also provides the opportunity to show that assessment which helps pupils to learn does not stop at deciding what they have achieved but includes suggestions for the next steps in progress. The final section in this guide shows interpretation in specific cases. It illustrates investigative work at levels A, B, C and D and shows how particular work may be interpreted in relation to the key features of knowledge and understanding. The discussion of each example concludes with suggestions for 'next steps' to help the pupils' progress. However, before turning to the examples, we will look at strategies which teachers might employ to help pupils move forward.

# 7 Advancing pupils' ideas and skills

When information has been gathered about where pupils have reached in developing ideas and skills and it is clear that they need help either to move on or to overcome difficulties, how are they to be helped? This section, based on research into teaching and learning in science, suggests strategies which teachers can use to advance pupils' ideas and skills in science.

The examples given later in this booklet illustrate what might be done in specific cases. This section draws together the patterns to be found in these examples.

The purpose of concentrating on 'next steps' is to help appropriate provision to be made for individual pupils, that is tailoring pupils' experiences so that each encounters the challenge to advance his or her learning.

This does *not* mean:

- separate activities for individual pupils (this would be undesirable as well as unrealistic, since it would obstruct pupils benefiting from group interaction).

What it *does* mean is that:

- pupils will be adapting and extending their tasks by developing their own skills and ideas
- teachers will be varying support from one pupil to another so that each pupil is challenged within the range of present capabilities
- the learning outcomes for individual pupils might vary even though they shared the same activity.

## *HELPING THE DEVELOPMENT OF SKILLS AND ATTITUDES*

At a general level, the following are some of the main ways of helping pupils to develop their process skills.

- Pupils have to use process skills in order to develop them: to use their own senses and to gather evidence from which to raise questions, form hypotheses based on existing ideas, and so on. Being told about what it means to observe, interpret or investigate is not the same as doing these things.
- Tasks should be designed to require pupils to share their ideas, to listen to others, to explain and defend their ideas so that they become involved in thinking through what they have done, relating ideas to evidence, considering others' ways of approaching a problem in addition to their own.
- During and after completing activities pupils should discuss how they have carried out parts or the whole of an investigation and should be encouraged to consider alternative courses of action and the extent to which these may be improvements. This will enable them to recognise the skills which they need to improve.
- In order to increase the accuracy of observation and measurement, for example, the use of instruments needs to be taught as and when the need for them arises. Other techniques, such as used in the construction of tables, the drawing of charts and graphs, and the knowledge of conventions in diagrams, are required for communication. Knowing how to use these instruments and conventions is not the same as using them appropriately, so there is more to

using these skills than the basic knowledge. However, using techniques appropriately depends on the pupils knowing how to use them.

Some more detailed suggestions, relating to particular strands of investigating, follow.

*Collecting evidence by observing*

Opportunity to use the senses as ways of finding out means that there must be objects and phenomena to explore. An 'interest' or science table in the classroom is one way of providing this as well as serving other purposes.

Some pupils also need invitations to observe. Cards placed next to objects or equipment displayed can encourage observation and action. 'Try to make this bottle make a high and a low sound' placed next to a bottle three-quarters full of water encourages interaction. 'How many different kinds of grass are there here?' placed next to a bunch of dried grasses encourages careful observation. The correct use of a magnifying glass can also be taught through a card with a drawing on it. Older pupils with the required manipulative skill can learn to use a microscope through similar informal opportunities.

*Planning*

Planning begins, paradoxically, from reviewing a completed task. The pupils' next planning can be helped by a good review, involving pupils and teacher, at the end of an investigation (whether or not the pupils planned it themselves). The process helps them to go through what was done and identifies the structure of the activity through the teacher asking such questions as:

- what were you trying to find out?
- what things did you compare? (identifying the independent variable)
- how did you make sure that it was fair? (identifying the variables which should be kept the same)
- how did you find the result? (identifying the dependent variable).

When a new investigation is being planned the lessons learned from this review can be recalled, remembering where perhaps variables were not controlled or initial observations taken when they should have been.

Planning continues throughout an investigation and indeed the initial plan may change as the work progresses and unforeseen practical obstacles emerge. However it is important for pupils to recognise when they are changing their plans and to review the whole planning framework when a change is made.

*Suggesting explanations and making predictions*

The development of pupils' confidence in their ability to suggest explanations is helped by asking for several possible alternatives in situations where there is not necessarily an obvious answer. For example, why are there patches of different coloured grass on the playing field?

Pupils often implicitly use patterns or hypotheses in making predictions but fail to recognise that they in fact do so. A girl who had investigated how far a wind-up toy travelled after different numbers of turns of the winder, when asked to make a prediction of how far it would go for a certain number of turns said that she guessed. Further probing, however, led to her describing that 'I thought that

it would be a bit more than for 3 and a bit less than for 5', suggesting that she was implicitly using a relationship of 'more winds means further'. Becoming aware of the pattern she was using enabled her to predict other distances with more confidence and indeed satisfaction. Discussion played a central part in bringing about this awareness.

*Interpreting and evaluating*

In order for pupils to develop ideas, they not only have to collect information and evidence to test their ideas, they also have to interpret what they find. That is, they must go further than collecting individual observations to see patterns, relate various pieces of information to each other and to ideas. For example, pupils measuring the length of the shadow of a stick placed in the ground at different times of the day must go beyond just collecting the measurements if the activity is to have value for developing ideas. The pattern of decreasing and then increasing length of the shadow and the possibility of using the pattern to make predictions about the length at times not measured, or about the time of day from the measurement of the shadow, and the development of ideas about how shadows are formed, are important outcomes from this activity. They all depend on using the results the pupils obtain, so the development of the skills required is important. In this, it is important to ensure that results are used and pupils do not rush from one activity to another without talking about and thinking through what their results mean.

*Recording and presenting information*

A personal notebook can be a useful tool for ongoing recording and later interpretation and reporting. At the least it is an aid to memory and at best it is a means of having a dialogue with oneself and assists reflective thinking. Pupils need help to use a notebook purposefully, but there is a fine dividing line between helping and checking up in a way which may inhibit the intended use.

Discussion of the best way to present information, either with a group or with the whole class if all have been doing similar things, provides an opportunity to introduce techniques for graphical representation or to talk about how to select the best way of presenting information. Work already displayed on the wall can be used as examples of how and how not to do this. Pupils are usually willing to criticise their own work after some time has elapsed.

*Using secondary sources*

Pupils need opportunities to use secondary sources of information - suitable reference books and other materials and time to use them - and some help in locating and selecting information.

## HELPING THE DEVELOPMENT OF IDEAS

The help that is appropriate will depend on the pupils' present ideas and how they differ from 'scientific' ideas. The three most common difficulties arise from limited experience, ideas which have not been properly tested and uncertain use of words. Appropriate help matches these problems.

*Extending pupils' experience*

Pupils' ideas may be limited by the experience they have had as, for example, when they assume that soil is essential for plants to grow or have little clear idea about how living things are adapted to their environments because they have studied few plants and animals and their environments in detail. In one sense these activities will be challenging views based on very restricted evidence but this is not in any way to suggest that their ideas are 'wrong'.

*Helping pupils to test their ideas*

Pupils may change their ideas in the light of evidence from an investigation. To do this the ideas have to be in a form which can be tested, although they may well be expressed in various ways. 'The ice melts because it is outside' is one such statement from a child which at first caused some surprise to his teacher. The hypothesis was based in this case on the location of the ice (which was, after all, where ice had been seen to form and melt) and not on the temperature of the place. A prediction based on this idea (about where the ice would not melt) could readily be investigated and thus the idea tested. The context in this case was a class discussion of what made ice melt, during which several different ideas were put forward and tested. The pupils whose ideas were not supported by their investigations therefore had immediate access to another idea which worked in practice better than theirs. The whole experience, of discussion and sharing ideas – and not just the activity itself – is important to the development and change in ideas.

*Discussion of words*

The pupil's understanding of a word can be developed through using it in practical work and the discussions which go on during the practical work. In an activity about sound, for example, pupils in the early years may begin to use the word 'vibration'. It will generally be used at first for 'vibration' which can be felt or seen and thus related to the use of the word in everyday experience (things which have motors in them, such as a washing machine, vacuum cleaner, electric mixer or power drill). So it will be easy to use the word in relation to a drum which is beaten or a guitar string which has been plucked. But what do children think is happening in a vibration? What examples of vibrating objects can they give? Do they think things which are not vibrating can make a sound?

Discussion of these things, with the pupils supplying instances of objects explored in their practical work will help them think again about what they have done (and perhaps go back to check things they took almost for granted) as well as to reflect on the words they use. At a later stage, and with older pupils, the questions would be more challenging and aimed at taking their notion of vibration further and towards vibrations which cannot be seen, such as those in air. Do things which make a sound vibrate? Can you have a sound without vibration? How does the sound travel from a vibrating object to our ears?

With these strategies for advancing pupils' skills and ideas in mind, we now turn to how they might be deployed in some examples of diagnostic procedures in action.

# 8 Examples of diagnostic procedures in action

This chapter presents and discusses examples of pupils' work in science. The aim of the discussion is to point out aspects which are useful evidence for assessing pupils' work and indicating how to help progress. It is worth emphasising that the comments on a piece of work only apply to this work and not to the pupil. To summarise a pupil's achievement would require the full range of relevant work to be taken into account. We cannot illustrate this process here, but we can indicate aspects of the work which teachers' should pay attention to when assessing their own pupils.

The examples fall into two groups, where the focus is on:

- Investigation skills (pages 20 to 31)
- Knowledge and understanding (pages 32 to 52)

The first group consists of five accounts of investigations. Each is discussed in relation to the strands of 'planning', 'collecting evidence', 'recording and reporting' and 'interpreting and evaluating'.

The second group comprises a set of shorter examples of work which gives some evidence of pupils' progress in relation to the attainment outcomes for: understanding living things and the process of life; understanding energy and forces; and understanding Earth and space.

The examples relate to certain of the key features of these outcomes set out in *Environmental Studies 5-14* for P1 to P3 and for P4 to P6.

## *INVESTIGATION SKILLS*

Evidence of the use of investigation skills comes as much from pupils' actions and talk during activities as from the products of their work. In most cases in these examples we have to rely on the account given by the teacher, but the first account benefited from being reported by an observer in the classroom throughout the investigation. Thus, although this work was carried out by P7 pupils, the detail of what the pupils did makes it a particularly rich example of interpretation of evidence, that is relevant to teachers of both older and younger pupils.

*Investigation skills: Levels A, B, C, D*

Example 1: P7 pupils investigating camouflage (B to D) ..... 20
Example 2: A P4 class engaged on a project about flight (B and C) ..... 24
Example 3: A composite P4/5 class working on a weather topic (A to C) ..... 26
Example 4: A group of P5 pupils working on a project on rubbish (A to B) ..... 28
Example 5: A P2 class engaged on a project on teeth (A) ..... 30

BEST COPY AVAILABLE

# Investigation Skills

## EXAMPLE 1

*Context: A group of P7 pupils investigating camouflage*

**Planning the investigation**
Pupils were studying camouflage within a project on World War Two. They worked in groups of 5 or 6, and were allowed as much time as they needed for their investigation. The teacher provided the opportunity for the pupils to decide the subject of their investigation and a structure for discussion and planning.

These able pupils worked fairly independently, although the teacher made a considerable input into the eventual choice of investigation. Other groups worked under closer direction by the teacher.

The group began work by referring to the structure provided. Ben suggested that they 'say ideas'. This provoked some general discussion which Ben recorded as single words, eg 'wars', 'colours', 'machines', 'army'. After ten minutes the idea of colour and camouflage was beginning to firm up.

Craig said 'we could make white paper men and then place them in a green background and find out which colours would make the best uniform to camouflage the men.' Ben readily accepted the idea and began to draw a plan. There followed a period of discussion of Craig's idea.

Then the teacher called the pupils together and asked what they were investigating. After some discussion they replied 'How does camouflage help in war?' and explained their plans. They were asked to write up their proposals for action the following day.

Next morning the teacher and group reviewed the work and agreed that the initial strategy was not going to work. The pupils decided to follow up the teacher's suggestion to paint backgrounds to test out their camouflage ideas. They chose to paint four different backgrounds: Arctic, desert, mountain and jungle. They researched in the school library for information to make these as authentic as possible.

**Carrying out the investigation**
They made twelve cut out figures from the same template, as in cutting paper chains, three for each background. These figures were then painted in the colours used in painting the backgrounds. Asked about the reason for this Anna replied 'for camouflage to work a man must be dressed in colours that match his background'.

Then they began to construct tables for collecting their data and at this point it was apparent that not everyone in the group was clear about the procedures for the experiment. A lengthy discussion ensued resulting in an agreed procedure. When questioned later about whether they should have planned this procedure earlier the

*Ben's report*

War

Camouflage

The experiment we did was to find out and prove what colours are best for hiding in the jungle, the desert the mountains and the arctic.

The first thing we did was to plan out how we wanted to do this. We decided to paint backgrounds on to pieces of paper. We also cut out 12 little uniforms each coloured for one of the four different environments we selected at the beginning which we had now made into the four backgrounds. We got a volunteer from the class to see what camouflaged uniforms could be seen from a distance of 10, 8 and 5 metres. We stuck all 12 uniforms up on the background.

The best uniform for the jungle was grey, we think this is because it was in the shadow of the background instead of the jungle part. The second, third and fourth best colours for the jungle were all mixtures of greens, browns and reds and yellows. The worst colour for this background is the yellow

Uniform Key

BEST COPY AVAILABLE

pupils defended their action, saying that it would not have been possible to plan their work in such detail at the beginning. Craig said, 'working like this is OK, it lets you change things for the better as you go along'.

The procedure they agreed and implemented was that each of the painted men would be numbered, one to twelve. All twelve would be placed against each background. A volunteer viewer (Paul, from another class) was asked to look at each scene at distances of 5m, 8m and 10m and to say at each distance which man was easiest to see. This was then removed and the easiest to see of the remainder was chosen, and so on until they could rank them all from 1 (least easy to see) to 12 (easiest to see). At the end of each block of observations the pupils re-measured the distances and checked their data. Ben disagreed with the need to repeat at three distances, saying that whatever could be seen at 10m would be seen at shorter distances.

During the 'jungle' test Paul said a light coloured figure was the easiest to see, contrary to the group's expectations. They realised the figure had been placed against the sky and that to make the test valid all the figures should be against the same part of the background.

**Reporting the results**

The pupils reached similar conclusions which they wrote into their own reports. They were clear that making a record of their work was important as it was going to form the basis of a report to the rest of the class. For this reason, they said, they did not use a database for recording, 'I think the rest of the people in the class would prefer to see my pictures and writing rather than just a database – it's boring'.

**Reflecting on the investigation**

Asked afterwards to reflect on the way they had made decisions and what they had done, they were

Ben's report

In the dessert background the best colours were the yellow and brownish orange colors did best with a couple of the jungle colors coming next. The worst colours in the dessert were the white and grey colours

The best colours in the mountains were the grey, the grey and blue and the grey, blue and white next. Were the white colours. The two worst colours were the yellows and the brown and green

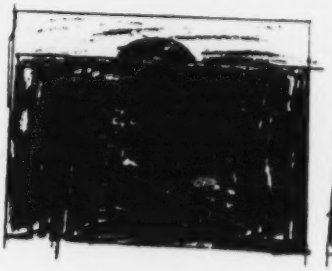
The top colours in the arctic were the whites The ones that showed up most were the yellows and "rangy" browns.

| | | | | |
|---|---|---|---|---|
| 1. | 9 | 6 | 7 | 11 |
| 2. | 3 | 4 | 9 | 10 |
| 3 | 1 | 5 | 8 | 12 |
| 4 | 2 | 2 | 10 | 5 |
| 5. | 7 | 3 | 11 | 1 |
| 6 | 11 | 10 | 12 | 6 |
| 7 | 10 | 8 | 1 | 8 |
| 8 | 4 | 1 | 3 | 9 |
| 9 | 5 | 11 | 5 | 3 |
| 10 | 10 | 9 | 6 | 2 |
| 11. | 6 | 7 | 2 | 7 |
| 12. | 4 | 12 | 4 | 4 |

You use this table by looking at the rankings on the side of the table. The numbers inside the boxes stand for different uniforms. Rankings go from 1 (the best camouflage easiest to see) to 12 (camouflage easiest to see). If you want to check the different colours numbers look at the keys on the first page. If you want to see the backgrounds turn to the next page

Backgrounds

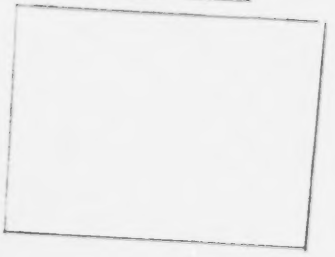
Jungle



Dessert

Mountains

Arctic



BEST COPY AVAILABLE

# Investigation Skills

pleased that they had changed from their initial plan. Keith said he was 'kind of happy with the planning but if I look back I think we should have talked more, taken our time'. The results were criticised by several of the pupils who felt that to be really 'true' they should have carried out the investigation with several different people.

## ASSESSMENT

During the investigation, there was ample opportunity to assess all six pupils in the group across the four strands relating to investigation.

| Related attainment target | Evidence of achievement |
|---|---|
| ***Planning*** | |
| Individually, or sometimes in small groups, with appropriate advice from the teacher the pupils will: | One of the factors distinguishing performances at C and D in planning is the amount of guidance given by the teacher. Although the teacher suggested the broad lines of the investigation, the planning of the details was carried out by the group. Ben's account opens with a clear statement of what he is finding out: 'what colours are best for hiding in the jungle, the desert, the mountains and the Arctic'. His plans are related to this. There is evidence of a considerable amount of thinking ahead, both in procedures and recording. The disagreement about whether a range of distances was needed is further evidence of thinking through what is to be done and checking for the adequacy of the plan.<br>(It is useful to note that had the assessment been made after the first half hour or so, the pupils would have been considered to have been operating at level C since they seemed uncertain about what they were going to do. It is important to give pupils the chance to go beyond the stage of exploring a number of possibilities in a fairly superficial way and time to focus on one course of action with some rigour.) |
| • given an area of enquiry, identify two of three important questions to investigate | |
| • decide on a sequence of tasks or procedures, checking for possible difficulties and adapting where required | |
| • propose methods and categories for recording and reporting findings and outcomes of enquiries (level D). | |
| ***Collecting evidence*** | |
| Undertake more extended investigations with attention to fair testing and safe practices (level D) | In Ben's account there is some attention to being fair (eg using the same person to judge and the same size of figure thus controlling some variables). |
| Select and use appropriate apparatus and techniques to collect information (level D). | Distance was measured with an appropriate instrument and measurements were checked. |
| ***Recording and presenting*** | |
| Record evidence in a variety of appropriate ways, now including making labelled and annotated sketches; constructing spread-sheet tables, data-bases, pie charts...writing appropriately illustrated and organised reports (level D). | The pupils selected a table rather than a database to record their results and they explained the figures in their reports. Ben gives only one set of results without stating the distance to which these apply, although we know that this was 10m. Ben uses drawings as well as words and has a particular audience in mind. The drawings are clear and informative but the writing lacks some structure and detail. All the pupils made rough notes during the planning period, and there was evidence of these being used in writing their accounts. |
| ***Interpreting and evaluating*** | |
| Draw conclusions (level B) | Ben wrote only a summary of the best camouflage colours for each background without giving reasons. Perhaps the explanation seemed too obvious, but there was room to comment on why certain colours showed up better than others against different backgrounds. |
| Draw conclusions, giving reasons (level C) | |
| Identify possible explanations (level C). | |

# Investigation Skills

## NEXT STEPS

### Planning

Ben's planning is well on the way towards level D. The progress of pupils such as Ben would be helped by more opportunities to plan extended investigations and to discuss plans in the group and with the teacher. They might be asked to identify clearly what is to be investigated and think of a range of possible ways of approaching the task.

### Collecting evidence

The group had a critical approach to the procedures chosen for collecting evidence. This progress could be helped by regular critical review of procedures and the opportunity to repeat parts of investigations with improved strategies.

### Recording and presenting

The pupils could be offered more suggestions for structuring their personal notes and using a variety of ways of recording information when the opportunity arises.

The next steps in reporting for Ben are towards the selection and organisation of content. Using a word processor may help him and his group to discuss and criticise their first drafts and redraft to provide an account which explains at each step the most important things the reader needs to know.

### Interpreting and evaluating

Ben could be helped to think further about the meaning of his findings, perhaps by being asked to address direct questions such as 'what does this tell you about camouflage?' 'how can you explain why different colours are best on different backgrounds?' and more general ones such as 'can you think of an explanation for what you found?' 'what other information do you need to be able to test your explanations?' In this way he could be helped to develop hypotheses and to make predictions which could be tested.

Notes

## EXAMPLE 2

*Context: P4 class engaged on a project about flight.*

As part of their work on flight the pupils visited a field centre on an estuary to watch birds landing and taking off in a stiff breeze. Back at school one of the follow up activities was to find out more about the effects of the wind.

Teacher: 'How does the wind affect you when you're moving about?'

Some pupils didn't think it made much difference. Others had experience of being blown about and finding it difficult to move against the wind.

Teacher: 'What would we need to do to find out how much difference the wind makes?'

Elena suggested: 'Try walking along a windy road and then do it again when the wind isn't blowing'

Chris said that might take too long – you would have to wait for the wind to drop. He added that you might walk faster on different days anyway. Paul said that it would be better to run because you could only ever run as fast as you can.

Teacher: 'What do you think would happen if you ran one way and then back with the wind behind?'

The pupils agreed that any difference would show up this way and set out to test it. They decided on a distance to run, which they measured out with a trundle wheel and used a stop watch. Rachel's results, entered in a table drawn up by the teacher, show what they did and what they found.

Discussing the results the teacher reminded them of the birds they had seen landing and using their wings to slow themselves down.

Teacher: 'How could you alter the effect of the wind when you are running?'

Rachel

Windy Sports

| Runners | Time with wind | Time Against wind | Difference in time |
|---|---|---|---|
| Elena | 11 seconds | 12 seconds | 1 second |
| Jo B | 10 seconds | 12 seconds | 2 seconds |
| Chris M | 9 seconds | 10 seconds | 1 second |
| Paul | 9 seconds | 10 seconds | 1 seconds |
| Rachael | 10 seconds | 12 seconds | 2 seconds |

Does the wind make a difference to your results? Yes the wind does make a difference to us Some the were slower against the wind

Can you think of sports helped by the wind? wind surfing

Can you think of sports made more difficult by the wind? rugby

The pupils suggested running with their arms outstretched and comparing this with running with arms held against them.

Chris tried this but said he couldn't run so well with his arms out anyway, so it wasn't fair. With the teacher's help they decided to use pieces of cardboard to increase their size. Chris's work describes what they did.

Chris

What We did

First We ran with the wind with the small card then with the big card with ways with and against the wind then we done it with ways with the long card.

What We Found

We found out running with the little card was easiest for my group because it was light and smaller against the wind It was hardest with the big card long way because could hardly see in front of me and the wind held me back.



BEST COPY AVAILABLE

# Investigation Skills

## ASSESSMENT

| Related attainment target | Evidence of achievement |
|---|---|
| ***Planning*** | |
| In discussion with the teacher and group/class, the pupils will:<br>Plan simple approaches to tackling tasks and solving problems, by asking questions, making suggestions, drawing pictures (level B). | The pupils received a good deal of help from the teacher in planning their investigations. However, they suggested simple approaches to tackling the questions, showing achievement at level B. For level C evidence is required of the pupils deciding what steps to take and in what order. |
| Propose simple headings under which to order or group information and evidence (level B). | The teacher provided the headings for the collection of results and for the conclusions. This activity therefore does not reveal evidence of whether the pupils could do this for themselves. |
| ***Collecting evidence*** | |
| Observe events and identify main aspects/happenings (level B). | When they observed the birds landing, the pupils noted how the spreading of wings was related to reduction in speed. This is evidence of sequencing main aspects and indicates progress towards level C. |
| Estimate and measure length, weight, time, using easily handled standard units (level B). | The pupils were measuring length and time in standard units. For work at level C the pupils would select the measuring instruments themselves. |
| Undertake practical tasks to seek answers with attention to safe and hygienic practices (level B). | The pupils gathered the information needed to see if the wind made any difference. However they did not pay much attention to detail or fairness, suggesting that they have some way to go to level C ('with attention to fair testing'). For example, when running with the wind and against it, they may have made the return run more slowly anyway, being tired. They could have tried both ways. The differences were very small and would have been more convincing if repeated. |
| ***Recording and presenting*** | |
| Record collected evidence in a variety of ways, including diagrams, charts, picture sequences, simple tables and databases (given headings) and short written accounts (level B). | The pupils completed the table of results set out by the teacher and all wrote accounts similar to Chris'. This is evidence of attainment at level B. There is evidence of some progress towards 'writing a logically ordered account' (level C) but it would be necessary to see what the children could do without the structure provided by the teacher. |
| ***Interpreting and evaluating*** | |
| Identify simple direct relationships, including cause and effect (level B). | Rachel responds to the question 'does the wind make a difference?' by saying that there is a difference and suggesting the relationship. At level C she would have tried to explain this relationship. |

## NEXT STEPS

The pupils are fairly easily meeting a number of the criteria for level B criteria. At level C they will make more decisions for themselves. The teacher could let them try some of their own ideas for investigations. (though there may not be such neat results as in teacher-designed ones!) The pupils will start to learn from experience why certain things have to be done, moving on from the stage of following instructions without thinking about the reasons for doing things.

Discussion of results encourages pupils to speculate about reasons for their findings and to begin to explain them, and review their methods. For example, in this investigation it was not necessary to measure out fifty metres or any other distance, providing it was kept the same. Critical review is a vital input into planning of subsequent investigation and important because it helps pupils to gain confidence in their own abilities to find answers.

# Investigation Skills

## EXAMPLE 3

*Context: A composite P4/5 class working on a weather topic.*

It was an unusually warm May and many pupils felt uncomfortable in their warm clothes. The pupils had been recording the temperature using a wall thermometer and the teacher took up their discussion about feeling hot and cold to see how they related this to their clothing.

They began by discussing differences in the fabric of their clothes, mentioning texture, thickness, type of material and colour. They discussed clothing worn for outdoor sports in summer and winter and they concluded that white was usually worn in warm weather.

Teacher: 'How could you find out if the colour makes a difference and not just the thickness of the cloth or something else?'

Jane suggested asking some tennis players. Other pupils objected that they would only know about what they were wearing and would not be able to compare.

Iain suggested 'put on a white shirt and then a dark one, like a grey one.' He did not suggest how the result would be found. When the teacher asked about how you would know whether there was a difference he said 'from whether you felt hot or cold'.

The pupils discussed whether 'feeling' was enough but it was the teacher who reminded them that they used the thermometer to see how hot or cold the room was. She asked them: Could they use a thermometer to see if the colour made a difference?

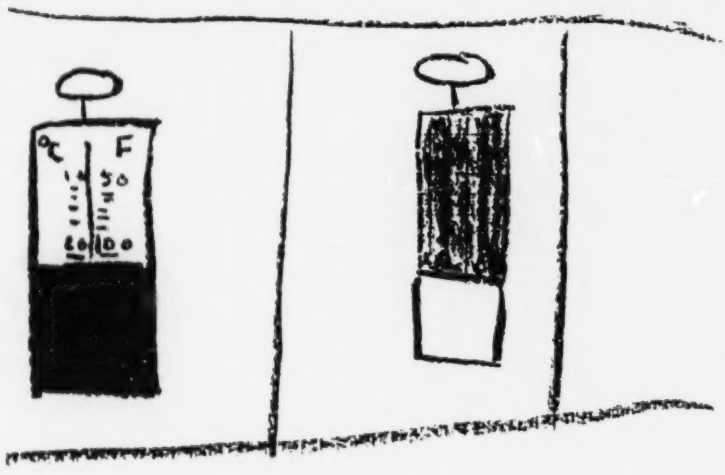
The first idea was to wear the shirts in the sunshine and then put the thermometer inside them. Joyce then said that you could just put the shirts in the sunshine and when they were ready put the thermometer inside each one.

The teacher suggested using paper instead of shirts and using two thermometers. She then reviewed with the pupils what they were going to do. She asked them how they would show the results.

'See which is the highest on the thermometer' was the general reply. Joyce's account describes what happened.

*Joyce*

Does the colour of our clothes affect how warm we become. We put black tissue paper and white tissue paper round thermometers. We found that the thermometer with black tissue paper round it was 35 and the thermometer with white tissue paper round it was 29. The thermometer with black tissue paper was the colour white and the other thermometer was brown this was the one with white tissue paper. If we had put one thermom ter in the open and one in the shade this would not be fair.






BEST COPY AVAILABLE

# Investigation Skills

## ASSESSMENT

| Related attainment target | Evidence of achievement |
|---|---|
| ***Planning*** | |
| In talking with the teacher, the pupils will:<br>Help to plan simple approaches to finding the answers to given questions by asking their own questions and making suggestions (level A). | The pupils' main role was to 'help' by responding to the teacher's questions. She had to prompt them about the use of the thermometer. There was some evidence, eg from Joyce, of the pupils doing some of the planning (progress towards level B).<br>The pupils did not respond to the teacher's invitation to decide what evidence would be collected or how they might record it ('propose simple headings under which to order and group information and evidence' — level B). |
| ***Collecting evidence*** | |
| Observe living things, objects and phenomena, noticing obvious features (level B) | The discussion revealed that they had noticed features of clothing and could distinguish between texture, thickness, colour and type of material. Other evidence would need to be added to this from other contexts to confirm the achievement at level B. |
| Use simple apparatus and techniques to collect information (level B) | Once the idea of using the thermometers was agreed, the pupils used them correctly. |
| Undertake practical tasks, to seek answers with attention to safety and hygiene (level B)<br>...with attention to fair testing (level C). | The practical work was carried out and an answer found to the question. They made sure that the thermometers were placed equally in the sunshine and also paid attention to another variable which they could not control, the difference in colour of the two thermometers. This was evidence of attention to fair testing and thus of some progress towards level C. |
| ***Recording and presenting*** | |
| Record collected evidence in a variety of ways including diagrams, charts, picture sequences...and short written accounts (level B). | Joyce's work is a short written account without any particular structure (level B rather than C). The diagram helps to show what was done, but some labels would have helped even more. |
| ***Interpreting and evaluating*** | |
| From recorded information and observation, identify simple direct relationships, including cause and effect (level B). | In the pupils' written work, there is no evidence of the results being interpreted in terms of the original question. It is possible that they assumed the interpretation since in this case it might seem 'obvious'. However without a discussion, or some comment on paper, it is not possible to know whether the pupils were operating at level B. |

## NEXT STEPS

Pupils are working towards level C in some aspects of the investigation but in others they have not reached level B.

They need help in planning and in interpreting and evaluating findings. In the next investigation the teacher could provide more time and structure in thinking about the practical work, first beforehand and then afterwards. For example, for planning, the teacher could ask:

- what do we want to find out more about?
- what are we making different?
- what must be the same to be fair?
- what will we look at to get the result?
- how will we make a record of the result?

Pupils might tackle these questions individually or in groups and pool ideas.

Planning should not become a dull routine, always written down, so that pupils feel that they have to stick rigidly to the plan even if, in putting it into action, they find something unanticipated. Part of the class discussion at the end of practical work might be to look over the original plan and see what changes had to be made. Future planning will be improved in this way.

Regular class review at the end of an investigation provides an occasion for pupils to use their results to say what they mean in terms of what they were finding out. This allows them to consolidate the development of ideas which is taking place as they explore their environment.

BEST COPY AVAILABLE

# Investigation Skills

## EXAMPLE 4

*Context: Group of P5 pupils working on a project on rubbish*

The pupils conducted a survey of litter and of waste materials from the school. There was a keen awareness of safety and hygiene precautions and parents had been informed that their children would be involved in studying rubbish. The pupils started with their own classroom bin. Wearing rubber gloves they sorted and classified the contents of the bin on five days, each group doing this on a different day and then combining their findings. They recorded the mass of different types of rubbish, such as metal, paper, wood, plastic, food.

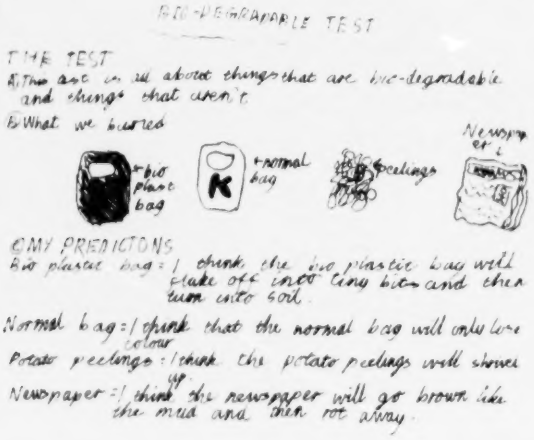
Finding that the school tuck shop was the source of most classroom rubbish led to a debate within the school about whether changes were needed. Later, work was done on rubbish in the playground and from the kitchen. This revealed a considerable amount of material which was used as packaging and the pupils questioned whether it was all necessary.

Discussion led to the suggestion of a study of the extent to which various items were bio-degradable. The pupils planned to bury selected items in soil and then to look at them every week. The items selected were a bio-degradable plastic bag, a normal plastic bag, potato peelings and newspaper. The pupils each made their predictions about what would happen.

To bury the items, the pupils dug holes which they measured with a measuring tape to make them all the same size: 10 cm square and 20 cm deep. Each week the buried items were uncovered and the state of deterioration assessed. Every other week the pupils took photographs to record the changes.

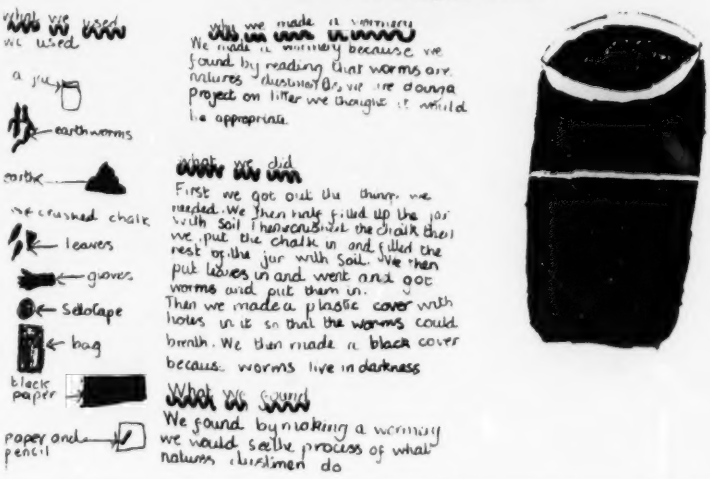
After some weeks there was no change in the bio-degradable bag and there was a discussion as to whether pupils should assist the process by making holes in the plastic bags. They decided against this and had to report that there was little difference between the two kinds of plastic by the end of their study. (A little later they planned and carried out an investigation to find out if the biodegradable bags were as strong as the regular plastic bags).

William


BIO-DEGRADABLE TEST
THE TEST
A) There are 4 things that are bio-degradable and things that aren't.
B) What we buried
+bio plastic bag
+normal bag
+peelings
Newspaper
MY PREDICTIONS
Bio plastic bag = I think the bio plastic bag will start to go into tiny bits and then turn into soil.
Normal bag = I think that the normal bag will only lose colour
Potato peelings = I think the potato peelings will shrivel up
Newspaper = I think the newspaper will go brown like the mold and then rot away.

Meanwhile the potato peelings were being eaten by creatures in the soil and this led to another study, of the action of worms, which they called nature's 'binmen'. The pupils decided how to record this work as follows.

Kay


MAKING A WORMERY
what we used
we used
a jar
earthworms
earth
crushed chalk
leaves
gloves
Sellotape
bag
black paper
paper and pencil
why we made a wormery
We made a wormery because we found by reading that worms are natures dustmen. So we are doing a project on litter we thought it would be appropriate.
what we did
First we got out the things we needed. We then made filled up the jar with soil. Then we crushed the chalk then we put the chalk in and filled the rest of the jar with soil. We then put leaves in and went and got worms and put them in. Then we made a plastic cover with holes in it so that the worms could breath. We then made a black cover because worms live in darkness
What we found
We found by making a wormery we would see the process of what natures dustmen do





BEST COPY AVAILABLE

# Investigation Skills

## ASSESSMENT

| Related attainment target | Evidence of achievement |
|---|---|
| ***Planning*** | |
| In discussion with the teacher and group/class the pupils will:<br>• given an area of enquiry, suggest a question to investigate (level C)<br>• select and order a sequence of activities or procedures for tackling a task or problem (level C)<br>• propose simple categories within which information and evidence can be organised (level C)<br>• in response to specific questions about their planning, suggest possible outcomes...and alternative strategies where difficulties become apparent (level C)<br>• check plans for safety and hygiene (level C). | The study of rubbish led to pupils suggesting questions about the rotting of plastic bags, the action of worms and testing the strength of plastic bags and carrying out investigations to answer them. This is evidence of attainment at level C.<br><br>In the study of rotting, the pupils planned to collect evidence by observing and photographing any changes in the buried items. Similarly in the investigation of rubbish from the school they thought through how they would collect information at regular intervals and what would be recorded. Categories for grouping the rubbish were identified.<br><br>A problem in the rotting investigation was encountered when there was no apparent change in the bio-plastic, which could have been due to planning over too small a timescale. This was not anticipated, although when revealed they did consider possible courses of action. In this respect their planning is approaching the requirement of level C.<br><br>In planning there was care for safety and hygiene, which seemed to go beyond simply following rules. To confirm work at level C, it would be necessary to be sure that the children had spontaneously considered these matters. |
| ***Collecting evidence*** | |
| Observe events and identify main aspects/ happenings (level B) | From this evidence, the pupils observed the main events, but not in the detail and with the sequencing which would meet the requirement at level C. For example, the action of worms in the wormery is reported by Kay in general terms rather than by describing the sequence of what happened. |
| Estimate and measure length, weight, time, using easily handled units (level B) | There was evidence of ability to measure weight and length appropriately. These activities did not provide opportunity to show more advanced attainment in measuring and using equipment. |
| Undertake practical tasks with attention to fair testing and safe and hygienic practices (level C). | In the study of rotting the pupils showed that they realised that a fair test had to be carried out. They insisted on the holes being in the same part and of the same size. Their concern for fairness was further demonstrated by their decision not to interfere with the natural process by cutting the bags. |
| ***Recording and presenting*** | |
| Record evidence in a variety of ways, eg sketches, annotated diagrams, a sequence of pictures, brief notes and logically ordered accounts (level C). | The pupils made effective use of annotated diagrams, sequences of pictures and photographs. The writing about the wormery has a good structure although it lacked detail in terms of content. |
| ***Interpreting and evalutating*** | |
| From recorded information, observations, and published information, draw conclusions, giving reasons (level C) | Conclusions were drawn from the rubbish survey about the impact of the school tuck shop. The rubbish investigations also led to conclusions about excessive packaging and the need for wider use of bio-degradable or recyclable material. |
| Make simple predictions (level C). | The predictions made about the buried items were based on past observations. |

## NEXT STEPS

These pupils show many signs of planning appropriate to level C in this investigation where the knowledge required was mainly 'everyday'. It is now important for them to have the opportunity to use these skills in situations where specific scientific knowledge and understanding is needed and where sources of information may have to be consulted. Pupils could be helped to plan more consciously, particularly in thinking through what might happen and setting up alternative courses of action based on possibilities. More attention to details can be encouraged in collecting and recording evidence as well as in planning. This would include opportunities to use more precise and more varied measuring devices. Pupils should also discuss and justify conclusions and evaluate their methods more critically.

# Investigation Skills

## EXAMPLE 5

*Context: A P2 class engaged on a project on teeth.*

The class had a collection of teeth from various animals and human teeth, with and without holes.

Part of the project began with a class discussion about food that was good for teeth and food that was bad for teeth. The pupils identified sugar as bad 'because it is sweet and will make holes in your teeth'.

The discussion was followed up by a question about how best to clean sugar from teeth. The teacher provided salt, cotton wool, tissue, as well as sugar and water. She did not include toothpaste because she wanted them to think about what it was about the material used that was good or not so good rather than to accept that toothpaste must be good because it is always used.

Before the groups started their investigation the teacher asked the pupils what they would need to be careful about when putting things into their mouths.

'Make sure it's clean', 'Don't put anything into your mouth unless a grown up tells you it's safe', 'Wash your hands first', were typical of the replies. The teacher assured them that the materials they would be using were clean and safe and they discussed how they would ensure that the investigation was carried out hygienically.

The teacher also asked each group to predict which material would be best. They all chose cotton wool 'because it is soft'.

Mark's group used all four materials as if they were all, including the sugar, being tried out as cleaning materials, rather than the sugar having a different role. They were asked to draw four pictures to show what they did and the teacher provided an outline table to record their results. They produced very similar records, of which Mark's (shown above) is typical.

*Mark*

| cotton wool | tissue | Sugar | salt |
|---|---|---|---|
| | | | |

The teacher reported that they changed their ideas about what was best for cleaning teeth as a result of the investigation but none of them entered anything into the table.

Mark concluded: 'cotton wool will be best because it is soft and jentle sugar will be worst because it will make holls in your teeth.'

BEST COPY AVAILABLE

# Investigation Skills

## ASSESSMENT

| Related attainment target | Evidence of achievement |
|---|---|
| ***Planning*** | |
| In talking with the teacher pupils will:<br>• help to plan simple approaches to finding the answers to given questions, by asking their own questions and making suggestions (level A) | The pupils selected materials to use but did not discuss how they would be used, apart from hygiene aspects. They used the sugar as if it was under test, so they were confused about what they were doing and why — they have not yet achieved level A. |
| • answer questions about simple rules for safety and hygiene (level A). | The pupils gave relevant answers to the questions about hygiene operating at level A. But the plans for the activity were too vague to be sure they were able to '...check plans for safety and hygiene' (level B). |
| ***Collecting evidence*** | |
| Undertake simple practical tasks to seek answers to specific questions (level A). | Tasks were carried out and a result achieved, but it was not clear how the result was arrived at. For example, did the pupils use their fingers or their tongue or some other way to judge the cleanness of their teeth? It is not clear that the task addressed the questions. |
| ***Recording and presenting*** | |
| Record collected evidence by drawing pictures, making lists and pictonal charts, writing captions and short pieces (level A). | The pupils drew the materials they used, not the way they used them or some other observation relevant to the investigation. They were not achieving at level A. They did not appear to understand how to use the table. |
| ***Interpreting and evaluating*** | |
| From recorded information and observations, answer simple questions about content and meaning (level A). | The pupils used their observations to say which was the best material and were not influenced by their initial ideas. There is no evidence, however, that they considered the meaning of this result in terms of the properties of the material. This would have to be confirmed before accepting that their work is at level A. |

## NEXT STEPS

The pupils need help to identify the purpose of their investigation and so to clarify for themselves the action they need to take. The teacher might help them to ask clear questions and then ask 'what will help us to find the answer?' 'how will we judge which is best?' A greater understanding of what they are looking for will also help pupils to make a record and to begin to discuss the meaning of the results. Occasional group presentation of results would help the pupils to clarify for themselves what they found and what it may mean.

Notes

## KNOWLEDGE AND UNDERSTANDING

Science education aims to help pupils to develop understanding, not just to learn facts or ideas by rote. It follows, then, that to assess understanding pupils need to be using ideas, not just recalling them.

The attainment of targets relating to the *Knowledge and Understanding* strand are differentiated by the extent to which pupils show 'secure knowledge and understanding of those key features of *Living Things and the Processes of Life, Energy and Forces, Earth and Space*', set out for the appropriate stages. Thus:

*Level A* means: secure knowledge and understanding of key features for P1 to P3

*Level B* means: the knowledge and understanding at Level A plus steady progress towards understanding of the key features for P4 to P6

*Level C* means: secure knowledge and understanding of key features for P4 to P6

*Level D* means: the knowledge and understanding at Level C plus steady progress towards understanding of the key features for P7 to S2

*Level E* means: secure knowledge and understanding of key features for P7 to S2.

Assessment therefore depends on the teacher being able to recognise 'secure knowledge and understanding' and to use this information to identify action to take to promote progress. The following examples illustrate this for the key features for stages P1 to P3 and P4 to P6. It is important to recognise that we cannot judge the pupils' levels of achievement from the single pieces of work discussed here. For that it is necessary to look across the whole range of a pupil's work. For older pupils this would mean examples of work for P7 to S2 as well as for P4 to P6. Some of the examples refer to work relating to P4 to P6 key features carried out by pupils in P7.

*P1 to P3: Understanding living things and the processes of life (pages 33 to 35)*
Example 6: Living ..... 33
Example 7: Keeping alive ..... 33
Example 8: Senses ..... 34

*P1 to P3: Understanding energy and forces (pages 36, 38)*
Example 9: Echoes ..... 36
Example 10: Energy at home ..... 37
Example 11: Moving ..... 38

*P1 to P3: Understanding earth and space (pages 39 to 42)*
Example 12: Moving sun ..... 37
Example 13: Moving earth ..... 37
Example 14: Ice ..... 38
Example 15: Uses of materials ..... 38

*P4 to P6: Understanding living things and the processes of life (pages 43 to 44)*
Example 16: Muscles and movement ..... 39
Example 17: Snails ..... 40

*P4 to P6: Understanding energy and forces (pages 45 to 49)*
Example 18: Sound ..... 41
Example 19: Circuits ..... 42
Example 20: Forces on objects in water ..... 43
Example 21: Flight ..... 43
Example 22: Slopes ..... 44

*P4 to P6: Understanding earth and space (pages 50 to 52)*
Example 23: Keeping warm ..... 45
Example 24: Insulating feathers ..... 45
Example 25: Materials ..... 46

# Understanding Living Things and the Processes of Life – Key Features for Stages P1 to P3

## EXAMPLE 6: LIVING

The teacher of a P2 class initiated a discussion of the pupils' ideas about what was living and not living by asking them to identify all the living things in the classroom.

Morag's group named: hamster, us, spider plant. Another group added 'daffodils' but this caused some disagreement because the daffodils were cut and not growing from the bulb. Eventually it was agreed that they were living because they would 'die' and they could not die unless they were alive first. (The teacher made a mental note to return to the topic of change in living and non-living material later.)

At this point he extended the range of living things by suggesting they looked out of the window, which added grass and a tree and at some posters on the wall, showing a robin, an owl, a squirrel, a whale and a horse.

The pupils all agreed that these were living. Which ones would the pupils group together because they were the same in some way? They each made drawings to express their ideas and the teacher discussed reasons as he went round to talk to them.

Some pupils put things together because they had pictures or soft toys resembling them; others grouped them as 'useful' or 'not useful'.

Morag's grouping and reasons were as follows:

| | |
|---|---|
| daffodil<br>*(it is a flower)* | owl<br>robin<br>*(they are birds and have beaks and feathers)* |
| whale<br>horse<br>*(they are both big)* | squirrel<br>hamster<br>*(they sit up and use their arms and they have fur)* |
| tree<br>*(the only thing with a trunk)* | grass<br>spider plant<br>*(they have spiky leaves)* |

### NEXT STEPS

Morag could not put the tree, the daffodil nor 'us' into a group with anything else. Where she did group things together it was in terms of their features, varying from the detail of 'having beaks' to the less specific 'both big'.

Morag used some observable features in making her groups, whereas the other pupils based their groups on their familiarity with the things or on aspects other than observable features.

Morag may need help to form broader groups including more things. Recognising similarities between different things is important to development of ability to classify things, and to the formation of concepts. The teacher might help, for example, by asking if there is anything that is the same about the tree, the grass and the spider plant, or the horse, the squirrel and the hamster.

Notes

BEST COPY AVAILABLE

# Understanding Living Things and the Processes of Life – Key Features for Stages P1 to P3

## EXAMPLE 7: KEEPING ALIVE

Following the grouping activities described in Example 6 the teacher explored the pupils' concept of 'living' by asking them to say what the living things they had been talking about needed to stay alive.

David: 'The daffodils and the spider plant need water or they go floppy and die'.

Teacher: 'Are they the only ones that need water?'

Morag: 'The animals need water - and we do.'

The teacher asked what she meant by 'the animals' and the answer was chorused by several children: 'the horse, the hamster and the squirrel.'

Teacher: 'What about the robin and the owl?'

The confident reply came 'They're birds' 'But they need water too.'

Teacher: 'What about the whale?'

Peter: 'It's got plenty, but it will die if it comes out of the water.'

The pupils discussed how the plants and animals obtained their water and recognised that the living things in the classroom depended on them for their supply.

Teacher: 'Is it just water that they need? What do we do for Hammy?'

The pupils then drew pictures of the hamster or the plants and wrote about how they were looked after.

Peter wrote: 'We give Hammy water and food and we clean his cage. He has his wheel for exercise and we talk to him. We are his friends'.

### NEXT STEPS

The pupils recognised that living things depend on their environment, or on human beings, to supply what they need to keep alive. Peter was able to say in detail how the hamster was cared for.

It is quite usual for pupils at this stage to consider only furry mammals to be 'animals'. They need more experience of the similarities in needs and characteristics of all animals before the word is used in its more scientific meaning.

Notes

BEST COPY AVAILABLE

# Understanding Living Things and the Processes of Life – Key Features for Stages P1 to P3

## EXAMPLE 8: SENSES

A project on 'the senses' in a P2 class was set off to a flying start by a visit from one of the pupils' relatives who was blind. She showed them Braille printing and explained how she used other senses as well as touch to replace information that would otherwise be gained through sight.

Following this visit, various investigations took place, for example some pupils were blindfolded and tried to decide what others were doing. They discussed deafness and went on a 'listening' walk, focusing on what they would miss if they couldn't hear, and they tried to find out what their class guinea pig could hear.

After the listening walk, Jamie drew a picture of the street and explained what he could hear to the teacher in these words:

*Jamie*

'I could hear the birds and a bus and a lorry and people talking and you telling us how to cross the road. If I didn't hear things I might not do this right. If I didn't see it would be worse, but then I could use a stick and touch the wall and the edge of the road. And I would still smell and enjoy the flowers and feel the sunshine.'

### *NEXT STEPS*

Jamie has put together recent information from the project with previous experience of using his senses, which might well be taken for granted. He understands that he depends on his senses for information and that he gains different kinds of information from each. He would benefit from opportunities to extend this understanding to less obvious information about orientation and balance and to explore the extent to which the senses can be relied upon, as in the sensation of hot and cold.

*Notes*

# Understanding Energy and Forces – Key Features for Stages P1 to P3

## EXAMPLE 9: ECHOES

A P1/P2 class went on a 'listening walk' round the school, intent on collecting as many different sounds as they could. They were keeping quiet and as they walked along the path by a wall they heard the sound of their footsteps change. Their teacher suggested it was an echo from the wall and they began to investigate.

Back in the classroom the pupils talked about other places where they had heard an echo and they were asked to draw what they thought made the echo. Kirstie drew this picture:

Kirstie

She explained: 'It's echoey because it's hollow; it's got nothing in it. You shout and it hits something and it vibrates off it'.

### NEXT STEPS

Kirstie's explanation suggests that she is developing a notion of sound as something that travels (then it 'hits something') and the drawing shows that the echo comes off the wall. She vaguely connects sound with something vibrating. However her drawing does not show any mechanism for producing the echo (unlike some of her classmates who drew lines to show sound reflected from the wall). Kirstie still needs some help to develop secure understanding of simple observable properties of sound. She could explore sources of sound where vibration is visible and make sounds in a variety of ways. Asking her to explain how she thinks sound reaches her ears from a source would also help her to sort out her ideas.

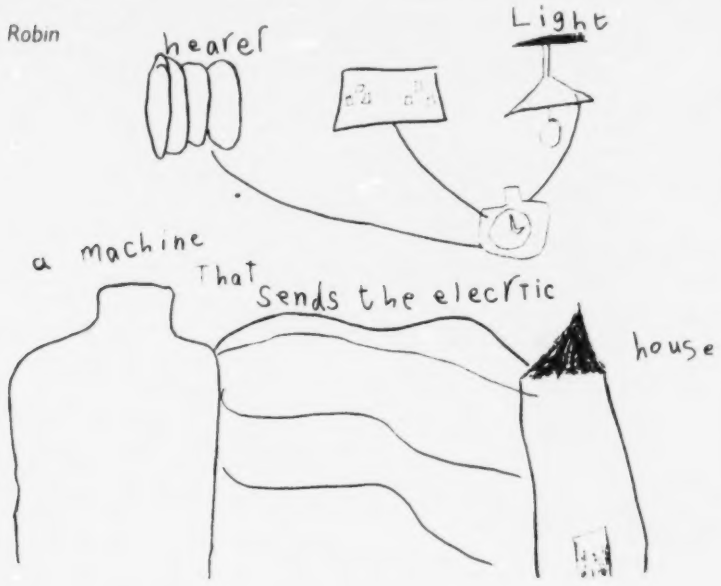
Notes

BEST COPY AVAILABLE

# Understanding Energy and Forces – Key Features for Stages P1 to P3

## EXAMPLE 10: ENERGY AT HOME

Robin (P2) drew this picture to help him explain how he understood where the electrical energy that is used in his home comes from.




### NEXT STEPS

He explained that there had to be wires from the 'machine' to the house. In the house he has drawn the meter with various wires from it to the light, the cooker and the heater. He would not be expected to use the term energy, but he shows that he realises that something is used in the devices and that this comes to the house in the form of electricity.

Robin's ideas could be developed by exploring forms of energy other than electricity. For example he could find out about heaters and cookers which do not use electricity and suggest how to provide light if there were no electricity.

Notes

BEST COPY AVAILABLE

# Understanding Energy and Forces
## – Key Features for Stages P1 to P3

## EXAMPLE 11: MOVING

With a P3 class, following a television programme about pyramids built by the ancient Egyptians, the teacher initiated a discussion about moving heavy loads.

Teacher: 'How many ways can you think of to move a heavy load?'

The pupils suggested lifting, carrying, dragging, rolling.

Teacher: 'How do you think we could find out which is easiest?'

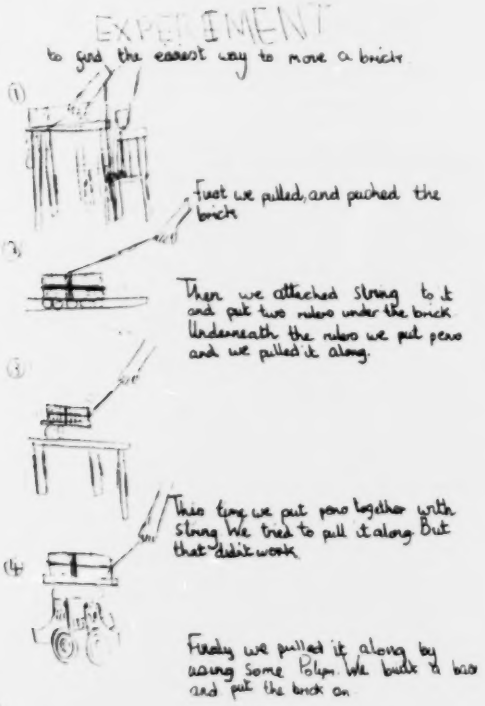
The pupils suggested trying various ways of moving a heavy brick. They then set out to find which was the easiest.

Their records describe what they did. Amy's and Robert's records indicate the range of performance.

Amy

Experiment To find the easiest way to move a brick.
Object.
You get a brick
then you get troupes of
then you get 3 sets of wheels
then you get lego of something
then finished
and the easyist Way Was When He got the lego and after that, We got the wheels the We where finshed

Robert


EXPERIMENT
to find the easest way to move a brick
First we pulled and pushed the brick
Then we attached string to it and put two rulers under the brick. Underneath the rulers we put pens and we pulled it along.
This time we put pens together with string We tried to pull it along but that didn't work.
Finally we pulled it along by using some Polyn We built it big and put the brick on
CONCLUSION
We found that step no. four was the easiest because the pens weren't good enough. The wheels were better because they were truly round. The pens were cylinders but not exactly accurate.

### NEXT STEPS

All the pupils' activities are based on applying the idea that to move something a pull or a push is needed—they understood effects of pushing and pulling on the movement of the brick.

Robert seems to understand the need for a force to make something move, but there is room for exploring these ideas further: what does he think makes the brick stop? What makes the brick so difficult to move in the beginning? Does he realise the force exerted by friction?

Amy does not explicitly mention pulling or pushing. It is possible that she considers that the wheels make the brick move easily without appreciating the forces that are at work. This would have to be explored by asking her to explain what she meant by 'easiest' and whether she had any ideas about why the wheels helped the movement.



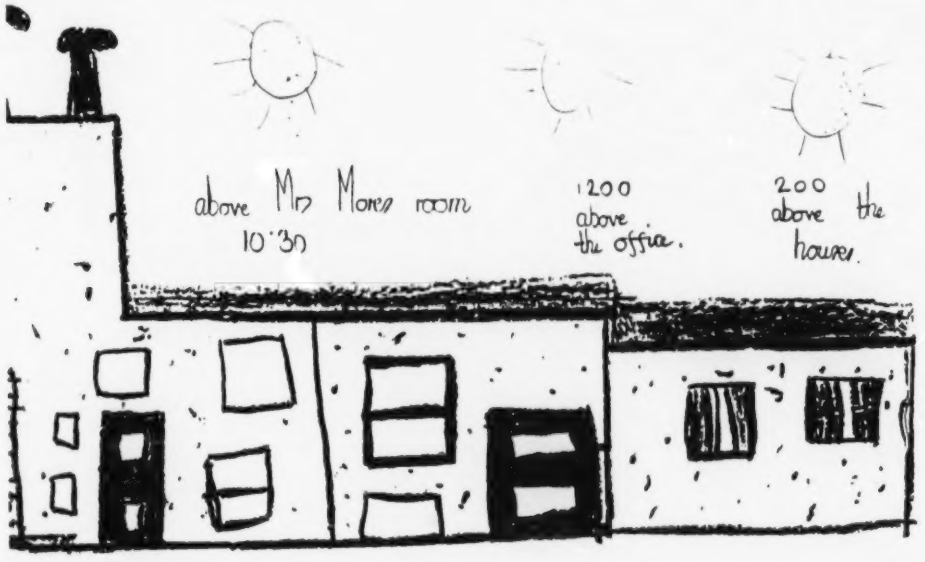
BEST COPY AVAILABLE

# Understanding Earth and Space – Key Features for Stages P1 to P3

## EXAMPLE 12: MOVING SUN

A P3 class had been working on shadows and, when possible, using the sun to cast the shadow. The changing position of the shadows from the sun led to a discussion of how the sun's position in the sky changed in relation to the earth during the day. The pupils kept a record of the position of the sun in the sky at different times of the day. Then, one day when the sun was hidden by dense cloud the teacher asked them to predict where it would be on an outline drawing of the school buildings which they could see from their classroom. Karen's drawing is shown here.

*Karen*




### NEXT STEPS

Karen's drawing shows that she is aware of the apparent movement of the sun across the sky but she has placed the sun at almost the same height in each drawing. For a full understanding of the pattern of movement of the sun she would need to extend her present knowledge to the change in height of the sun in the sky and to its rising and setting.

Notes

BEST COPY AVAILABLE

# Understanding Earth and Space
## – Key Features for Stages P1 to P3

## EXAMPLE 13: MOVING EARTH

In another P3 class the teacher helped the pupils to envisage the reason for day and night using a model.

Bruce's drawing and writing indicates the understanding he has developed.

*Bruce*

We used a torch and globe to show this

All the light and all the heat on earth comes from the sun. The earth takes 24 hours to spin round. This is how a day is 24 hours. When it is night time for us it is daytime for the people living on the other side of the world.

*NEXT STEPS*

Bruce displays a secure knowledge of the sun in relation to the earth, not only how day and night arise from the spin of the earth but also how the sun provides heat and light energy. The teacher could explore how far Bruce can use this model to explain the apparent movement of the sun across the sky, for example, and what can be seen from the earth on the dark side.

Notes

BEST COPY AVAILABLE

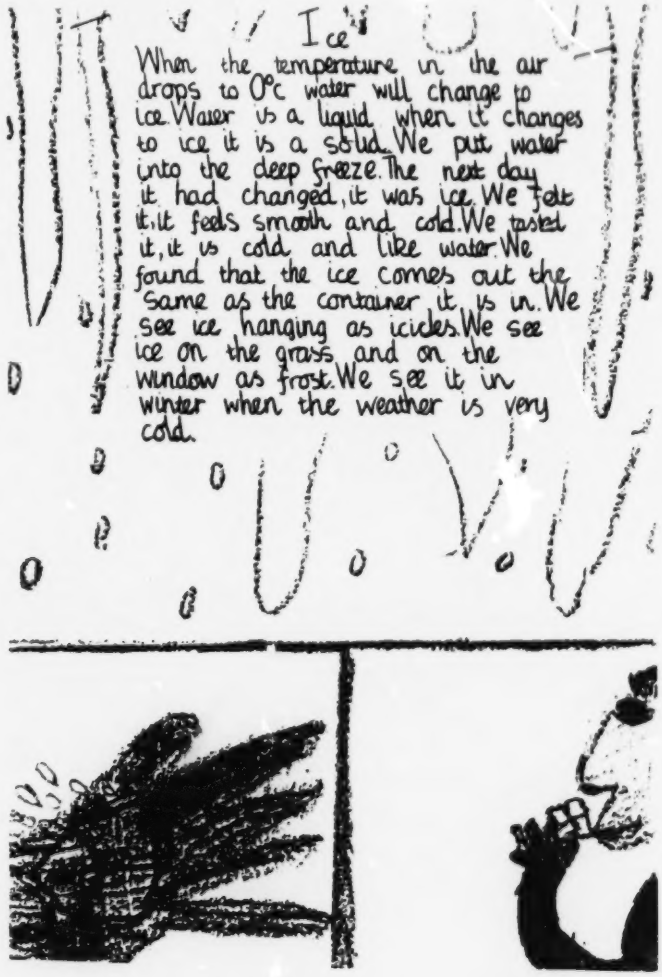
# Understanding Earth and Space
## – Key Features for Stages P1 to P3

## EXAMPLE 14: ICE

During a study of the weather P4 pupils froze water and discussed the various places where ice appears and the forms it can take.

Mananne's record is shown here.

Marianne


Ice
When the temperature in the air drops to 0°c water will change to ice. Water is a liquid when it changes to ice it is a solid. We put water into the deep freeze. The next day it had changed, it was ice. We felt it, it feels smooth and cold. We tasted it, it is cold and like water. We found that the ice comes out the same as the container it is in. We see ice hanging as icicles. We see ice on the grass and on the window as frost. We see it in winter when the weather is very cold.

### NEXT STEPS

This work shows awareness of the forms that ice can take and how the solid form of water differs from the liquid. Mananne is clear that both are water. However, although she mentions 'the temperature in the air' dropping to zero, she does not explain where the water that forms ice and frost comes from. Her understanding is at the level of simple weather features. She could be helped to develop the idea of presence of water vapour in the air through investigating and discussing the formation of condensation.

Notes

BEST COPY AVAILABLE

## Understanding Earth and Space – Key Features for Stages P1 to P3

### EXAMPLE 15: USES OF MATERIALS

Shown here is a drawing by Ryan (P1) of things made from various materials.

The teacher discussed Ryan's drawing to find out his ideas about the suitability of materials for different uses (and to find out why the chair and table were included as metal).

Ryan explained that glass was for things that you needed to see through. Metal could be bent into different shapes easily and was strong. He thought wood was easy to cut and plastic was stretchy. The chair and table had metal legs and that was why they were there.

Ryan

#### NEXT STEPS

Ryan has a good understanding of the uses of common materials and is beginning to relate these to the properties of the materials. To help this progress he would benefit from exploring the properties such as strength, hardness and stretchiness a little more.

Notes

BEST COPY AVAILABLE

# Understanding Living Things and the Processes of Life – Key Features for Stages P4 to P6

## EXAMPLE 16: MUSCLES AND MOVEMENT

A P6 class watched a television programme on muscles, bones and joints, and then the teacher asked if they thought all joints were the same. This lead to groups searching for different kinds of joints in different parts of the body.

Main's was the 'arm and hand' group. They decided to see what it would be like to be without joints, putting splints on their fingers and then trying to write. They found it was more difficult to prevent movement of the wrist than the elbow and identified these joints as different.

Their teacher asked them to draw how the joints moved and to think about how the movement was caused. They identified muscles in the arm as being important.

Gerry said, 'your muscles help you push and pull'.

The group then investigated the strength of their arms by a form of table-top tug-of-war.

The teacher asked them to put muscles on their drawings. Main's drawings show only one muscle in the arm. The teacher asked her,

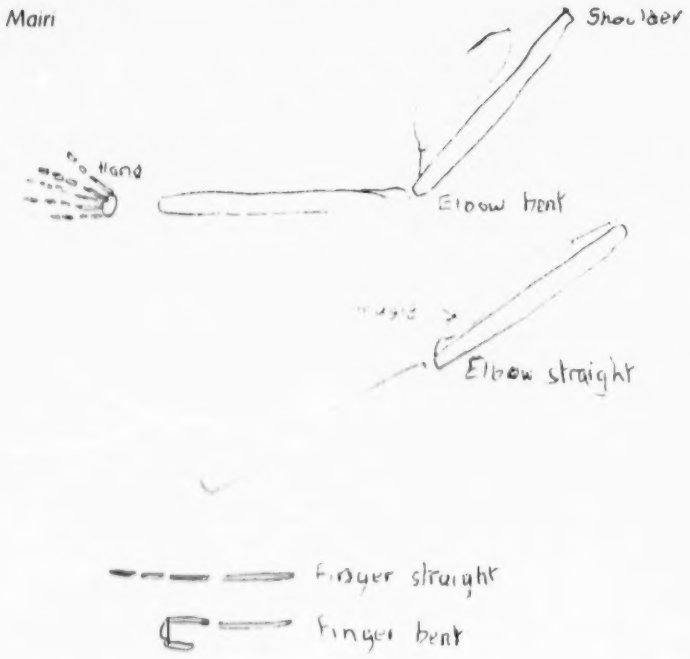
'Are there muscles anywhere else?'

Main replied, 'Yes, in your legs.'

The teacher asked,

'What about your fingers?'

Main: 'No, they're just bone and skin.'




### NEXT STEPS

Main's drawing shows careful observation of the movement of the joints at the elbow and fingers. However, she is not connecting muscles with movement, perhaps only with strength. The attachment of the muscle to the arm shows no understanding of how it acts in bending the arm. Her denial of muscles in the fingers again suggests the need to develop ideas about the role of muscles in bringing about movement.

The pupils' thinking about movement of bones might be extended by asking them to make a cardboard model arm and attach strings or rubber bands to make its parts move. This might be followed by discussion about other joints, including the fingers, to explore the extent to which the function of muscles has been generalised. The children might then be helped to realise the effect of muscle disease even when bones are healthy.

Notes

BEST COPY AVAILABLE

# Understanding Living Things and the Processes of Life – Key Features for Stages P4 to P6

## EXAMPLE 17: SNAILS

P6 pupils collected a variety of minibeasts. At first they were determined to keep whatever they found, but after one or two disasters they decided to take most creatures back to where they had been collected observing them. However, they set up a successful snailery; the snails survived and laid eggs, a sign that they took to indicate, following David Attenborough, that they must have suitable conditions.

The pupils observed the snails over several weeks, raising questions about how they would react to different conditions and foods: flour, salt, ice, water, sand, paper, etc.

The teacher asked them to predict, from their observations, what the reactions of the snails would be to the substances before they tried them.

In the case of water they expected the snails to be attracted to it, having found that sprinkling them with water would rouse them when they became dormant during warm weather. Sure enough, when the snails were surrounded by a circle of water, they went round and round in it. But the pupils could not predict what the reaction to flour would be. The snails loved it. Not so the salt, which immediately made any snail which touched it rear up.

Teacher: 'Why do you think the snail doesn't like the salt?'

James: 'Perhaps because it's rough.'

Paul: 'But they don't mind going over the sand, so it probably isn't that.'

James: 'Perhaps it's the colour.'

Paul: 'But they liked the flour.'

The teacher suggested that the pupils might go on thinking about this and see what they could find out from books and other people. These ideas were later shared.

### *NEXT STEPS*

The pupils were gaining an understanding of the conditions needed by living things and that these differed from one type to another.

They noticed that the necessary conditions often indicated dependence on other living things, especially plants, for food. Their willingness to return the creatures to their habitat indicated some development of the attitude of responsibility towards the natural environment.

Paul, for one, used evidence and past experience to interpret observations. This suggests that pupils could readily be helped to develop beyond noticing differences in the conditions needed by living things to relating these to the features and characteristics of the living things, moving towards ideas about adaptation. These concepts could be developed in relation to plants as well as animals.

Notes

BEST COPY AVAILABLE

# Understanding Energy and Forces – Key Features for Stages P4 to P6

## EXAMPLE 18: SOUND

In the course of a project on sound, pupils in P7 made sounds of different pitch from milk bottles with varying amounts of water. They wrote accounts of their experiments.

### NEXT STEPS

Although some of Jennifer's account of her findings about high and low notes do not accord with results to be expected, from her explanation of how 'blowing across the top of the bottle makes the air inside the bottle vibrate' it appears that she understands the relation between sound and vibration. The teacher could use this context to help her develop ideas about pitch and distinguish this from volume. Similarly Bryce uses the notion of vibration in the air to explain how the sound gun makes the candle go out.

There is no evidence that William connects sound with vibration. He describes what happened without giving an explanation. It would be important to probe his understanding as he may need more opportunity to explore sources of sound and to develop an understanding of key features of sound appropriate to earlier stages.

*Jennifer*

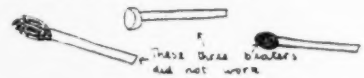
Bottle Organ

Experiment - We did an experiment to see if we could tune bottles

Equipment - 8 milk-bottles jugs of water 4 beakers

Method - We poured water into the eight milk-bottles at different levels We then blew across the top of each bottle in order to produce a note We found that the more water in each bottle the less air in each bottle the deeper the note The less water in each bottle the more air in each bottle, the higher the note So therefore blowing across the top of the bottle makes the air inside the bottle vibrate

Then we tried using four different beakers to put the bottles with to try and produce a different note The two soft tipped beakers and the rubber tipped beaker did not produce a note. The hard plastic tipped beaker did produce a note and it sounded better than when we blew across the bottles



These three beakers did not work

This small plastic tipped beaker did work

The pitch of the note depends on the amount of air inside the bottle and so therefore it also depends on the amount of water inside the bottle

*William*

Experiment
To find a tune in the bottles

Equipment 8 milk bottles and water and Beakers

What We did
We blew over the top of the Bottles and I heard a Sound. We used the beakers to get a tune

Whathappend We got a tune

*Bryce*

Experiment - making a sound gun to put out a candle with out touching the candle or blowing it out

Equipment - toilet roll tube
two circles of foil to cover ends of tube. One circle of card must have a hole about 1cm in diameter.
Sellotape
candle stuck in saucer
match

What we did - first we stuck the candle and stuck it to the plate with not wax then we made the sound gun then after that we hit the gun.

What happend - the light went out because of the vibrations hitting the light and making it flicker and then go out.

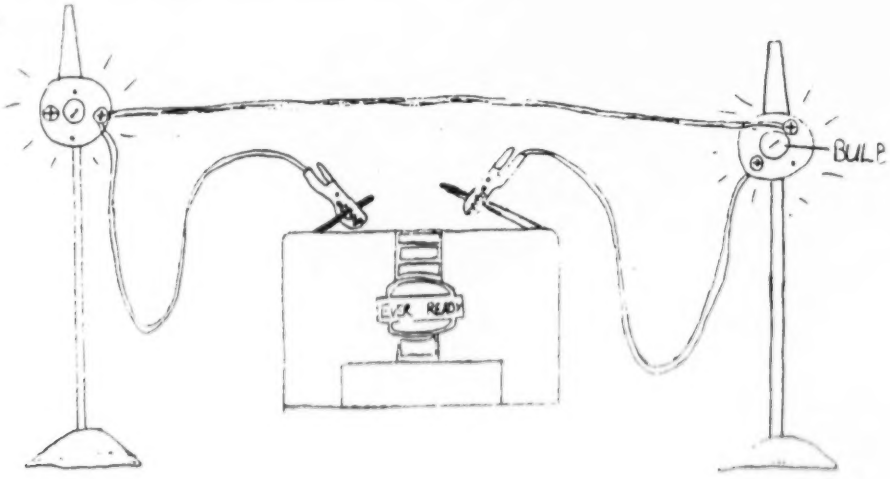
BEST COPY AVAILABLE

# Understanding Energy and Forces – Key Features for Stages P4 to P6

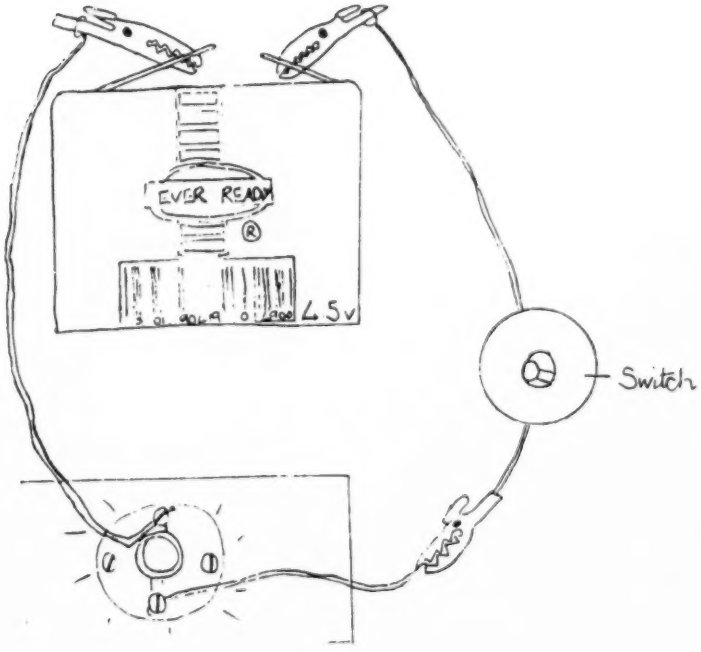
## EXAMPLE 19: CIRCUITS

A P5 class were making bulbs light up in simple circuits and putting in switches. Here are the drawings of two pairs of pupils.

*Steven and John*




*Beth*




### NEXT STEPS

Is the mistake in Steven and John's drawing just a slip or have they not realised the importance of a circuit including the bulb, even though they clearly succeed in making the bulbs light? The teacher could talk to them about their drawing. Do they think it matters where the wires are attached to the holder? What do they think is between one connecting screw and the other? Such discussion would help to clarify their grasp of a simple circuit and their readiness to explore the function of switches and other components.

Does Beth understand that a switch makes or breaks a circuit? Her work suggests that she knows how to connect a switch into a circuit but does not indicate that she knows what the switch does. Using a simple home-made switch rather than using a ready-made one would enable her to see what happens when it is on and off. Lots of experience of making and breaking circuits in different ways may be needed for a firm grasp of what a continuous circuit means beyond the mechanical connections of wires and clips.



BEST COPY AVAILABLE

# Understanding Energy and Forces – Key Features for Stages P4 to P6

## EXAMPLE 20: FORCES ON OBJECTS IN WATER

Jane and Mairi, in P6, investigated forces on objects in water. Their account is shown below.

*Jane and Mairi*

'We used polystyrene, a bucket, a spring balance and a metal toy car. We were trying to see how heavy the car would be in water and out of water. We found out that the weight under water was just over 200g and weight out of water was just over 300g. We think that it was lighter in water because the water was pushing the car up. We think that water can be useful for carrying something very heavy. It would be easier to take it in water rather than by road.'

When they tried weighing the polystyrene in water they were surprised to find that it appeared to have no weight. But this confirmed their idea that the water was pushing up, although they could not measure by how much.

*NEXT STEPS*

The pupils appeared to be developing sound ideas about the effects of opposing forces.

Realising that the polystyrene would have to be pushed down to be under water might be the next step in moving towards a quantitative grasp of balanced and unbalanced forces. Giving them the problem of measuring the downward force required to hold the polystyrene under water would be a step in this direction.

Notes

BEST COPY AVAILABLE

# Understanding Energy and Forces – Key Features for Stages P4 to P6

## EXAMPLE 21: FLIGHT

Within a topic on flight, pupils in two classes investigated the effect of air resistance by dropping similar sheets of material laid out flat or screwed up into a ball. The accounts of Amanda (P5) and Alasdair (P7) are given here.

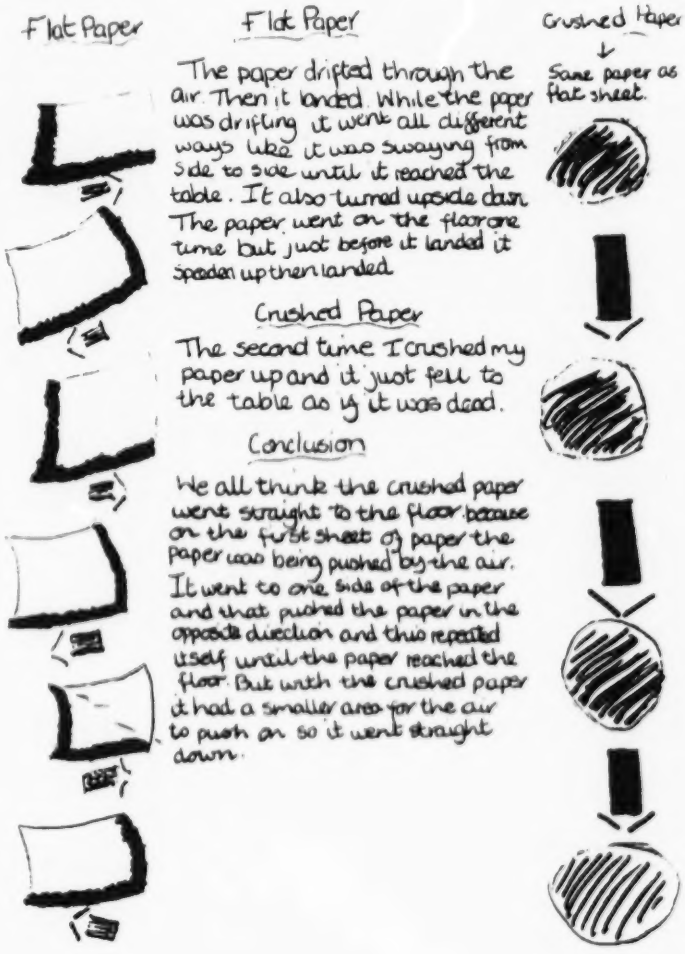
*Amanda (P5)*

What you need – Some aluminium kitchen foil, a chair

What you do – Cut out squares 10x10 centimetres from the kitchen foil. Roll each square into a tight ball. Stand on the chair and hold one ball in each hand. Hold your hands above your head. Drop the balls together.

What happened – When Colin dropped the 10x10 ball and the other 10x10 ball both hit the floor together. When I tried the 10x10 ball and the 10x10 sheet the ball hit the ground first because the gravity was round the ball and the air was under the sheet making it float down.

*Alasdair (P7)*


Flat Paper
Flat Paper
The paper drifted through the air. Then it landed. While the paper was drifting it went all different ways like it was swaying from side to side until it reached the table. It also turned upside down. The paper went on the floor one time but just before it landed it speeded up then landed.
Crushed Paper
The second time I crushed my paper up and it just fell to the table as if it was dead.
Conclusion
We all think the crushed paper went straight to the floor because on the first sheet of paper the paper was being pushed by the air. It went to one side of the paper and that pushed the paper in the opposite direction and this repeated itself until the paper reached the floor. But with the crushed paper it had a smaller area for the air to push on so it went straight down.
Crushed Paper
Same paper as flat sheet.

### NEXT STEPS

Amanda has confused air resistance and gravity and does not seem to see these as opposing forces in downward motion. The activity does not appear to have helped her to clarify these ideas and she may need help to consolidate earlier ideas about forces and motion before she can understand the operation of air resistance.

Alasdair explains the difference he observed in terms which show a grasp of air resistance and how it relates to surface area. He could be encouraged to think about how he might use the idea in relation to horizontal motion so as to explore the extent to which he sees the air resistance opposing motion in whatever direction.

Notes



BEST COPY AVAILABLE

# Understanding Energy and Forces
## – Key Features for Stages P4 to P6

## EXAMPLE 22: SLOPES

As part of a number of activities about slopes, a group of P7 girls was given the task of answering the question 'Is there a connection between the angle of a slope and the distance an object rolls down this slope?' The pupils decided to measure the angle of the slope using the skills they were learning from other activities. From their results they drew a graph of how the distance varied with the angle of the slope. Other groups obtained similar results. The reports of Gillian and Ann are given here.

*Ann*

Slope Angle

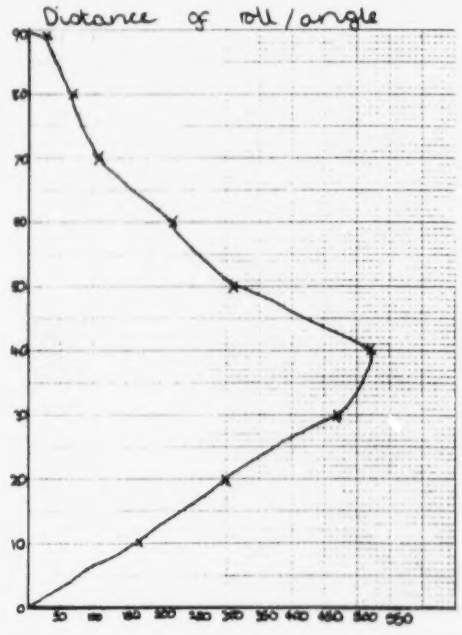
Is there a connection between the angle of a slope and the distance an object rolls down this slope? What did you find first of all we got a cylinder, a piece of cardboard and a metre stick. Somebody held the piece of cardboard somebody else got the cylinder and let it roll down the cardboard next we measured how far it went and what the angle was. We noticed that the cylinder didn't go as far when it got higher up. We had a few problems with the cylinder because it kept on going the wrong way.

*Gillian*

Slope Angle

Is there a connection between the angle of a slope and the distance an object rolls down this slope? What did you find First we had a board and a roll. We layed the board at a slant and record the angle and the height Then we rolled the roll down and recored the distance. It went It went quite well but sometimes it crashed or went squint. We found that it went further each time until we reached 40°. Then it started to go less and less and at 90° it only went 32 cm because it bounced so much.

*Graph*




### NEXT STEPS

Ann's report is neat and well worded, but her account concentrates only on what happened at the higher angles. She did not question this or try to explain it. Gillian, however, although her account is less well expressed, describes all the results. She offers an explanation of why the cylinder did not go far at the highest angles, suggesting that she expected something different.

It would be helpful to both to discuss with them what they expected to happen. Why did they think that at first the cylinder rolled further the higher the angle? Would they have expected this pattern to continue? In this way their grasp of differences in energy related to position might be explored. Holding the slope at one angle and seeing what happens when the cylinder is started at different points along it might help to establish this relationship.

*Notes*

BEST COPY AVAILABLE

# Understanding Earth and Space – Key Features for Stages P4 to P6

## EXAMPLE 23: KEEPING WARM

A P6 class was studying how to reduce heat loss from buildings in winter. The teacher began by finding out their ideas about the insulating properties of materials. It was clear that the pupils were aware that thick padded jackets were used round hot water tanks because 'the padding stops some of the heat escaping and helps keep the water hot'. They were also clear that a tea cosy was acting in a similar way and that several layers of clothes helped to keep them warm.

The pupils then talked about why certain material felt warm or cold to the touch.

Hannah explained feeling some polystyrene being warm as follows. 'because it is lots of bits and is much lighter. Also heat could get trapped there'.

Fiona said, 'More heat is held in the polystyrene because it is thicker and packs in more heat'.

In both cases it seems that their attention was to the form of the material rather than its intrinsic property.

The teacher then asked pupils to choose between cotton wool, bin liner plastic, cardboard and aluminium foil as the best for keeping a hot pie warm. Most pupils, including Fiona and Hannah, chose the aluminium foil. Reasons varied from 'because it would be the strongest' to 'because my mother uses it'. They rejected the other materials because of their suitability for wrapping rather than their insulating properties. This led to the investigation of the insulating properties of the materials by wrapping them round mugs of hot water.

### NEXT STEPS

These events indicate that the pupils were considering the suitability of the material for particular uses and that the insulating property was not the foremost in their minds when they were considering how to keep the pie warm.

In the terms they had in mind the choice of foil was sensible – particularly as pies are usually sold in foil trays – but they needed help to separate the two functions and to realise that whilst the foil would help to keep the pie whole it would not help to keep it warm.

Notes

BEST COPY AVAILABLE

# Understanding Earth and Space
## – Key Features for Stages P4 to P6

## EXAMPLE 24: INSULATING FEATHERS

Joan's account of a P7 class experiment gives a clear account of what was done but reveals rather less about her ideas.

### NEXT STEPS

The conclusion precedes the evidence in the account. This may be because she had a good idea of what she expected to happen and was testing this out.

The activity could be used to extend Joan's ideas further, for example, she could be asked: 'why do you think the feathers kept the water warmer?' 'what else do you think would keep the water as warm?'

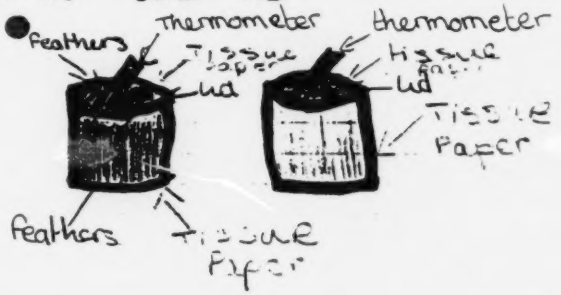
The pupil might perhaps be encouraged to extend her ideas about feathers to insulation more generally, perhaps recognising the insulating property of air.

The teacher could discuss whether or not the irrelevant details should have been included in the account but this would depend on what the teacher had in mind for this piece of work and for this particular pupil. In P7 most pupils would be moving towards more selective and organised records.

*Joan*

Testing Feathers for insulation

Today at school primary seven did an experiment about feathers. Hazel broke one of the plastic tubs but it couldn't be helped. The experiment still worked. The tubs both had green tissue paper on them. The tissue was very thin. One of the tubs had feathers covered all over it. Even the lid of the tub was covered in feathers. The other lid wasn't covered in feathers. Mrs Wood boiled the water for a minute. So the plastic tubs wouldn't melt. Mrs Wood poured the water into the tubs and 2 minute later we put the thermometers in the tubs. We found out that the feathers kept in body heat. We knew because the water in the tub with the feathers was warmer than in the other tub.




Notes

BEST COPY AVAILABLE

# Understanding Earth and Space – Key Features for Stages P4 to P6

## EXAMPLE 25: MATERIALS

Rosa and David (P6) described their developing ideas about materials in the following account which they word-processed.

*Rosa and David (1)*

We used sand, water, marbles, polystirene tray and a yogurt cup. It was good doing the expenment. We put 34 marbles in the yogurt cup then we put 6 spoons of sand in the yoghurt cup and last of all we put 20 spoons of water in the yogurt cup. We think there were spaces between the marbles which we filled up with the sand. Then there must have been spaces between the bits of sand which we filled up with water.

The teacher then asked them: 'Do you think the sand would dissolve in water?' What they then did was described in their next piece of word-processing:

*Rosa and David (2)*

We were trying to dissolve a little bit of sand in a lot of water. We had to shake the sand and water in a cup with the lid on it. Then we had to use a funnel. We had to put a funnel in a jug and pour the water that we had shaken in the cup through paper. We did not put the sand in it. We left the sand out of the jug to see if any of the sand had dissolved in the water. So we tried it out but the water was clean and the paper was clean so the sand never dissolved. It just looked like it did.

### *NEXT STEPS*

Rosa and David do not use relevant evidence to decide that the sand had not dissolved. This could indicate that they need to develop their understanding of the concept of dissolving.

It might help to discuss with them: suppose the sand had dissolved, where would it be? would they expect to be able to see it? how would they try to get it back?

Answering these questions for a substance that dissolves easily might also be helpful.

Notes

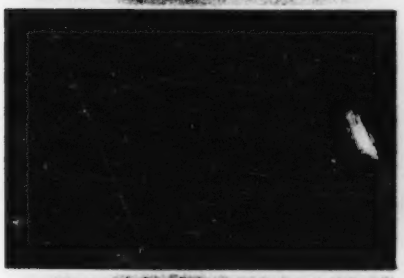


BEST COPY AVAILABLE

*Taking a Closer Look at*

# SCIENCE

Helping teachers to teach and pupils to learn is the key objective of the diagnostic procedures series. The sets of materials, for English language, Mathematics and Science, draw on existing research and practice and apply it in the context of curriculum and assessment for Education 5–14. The authors offer guidance on diagnostic and developmental techniques, illustrated by examples from the classroom, which will help teachers to assess pupils' understanding and progress and identify appropriate next steps to help pupils make progress.



The publications aim to assist schools to develop curriculum and assessment policies and to help individual teachers assess pupils' learning in a way which fits in with day to day teaching.

The *Science* pack contains:

- **Key Ideas in Diagnostic Assessment** – introductory booklet
- **Taking a Closer Look at Science** – teacher's guide

*Key Ideas in Diagnostic Assessment* introduces the series and explains the principles of diagnostic assessment, offers advice on when to take a closer look, identifies strategies for gathering evidence and looks at factors linked to successful learning.

*Taking a Closer Look at Science* focuses on the use of diagnostic procedures in developing scientific ideas and the skills associated with investigating. The booklet offers guidance and support on:

- using questions to explore pupils' preconceptions
- ways of gathering high-quality evidence
- interpreting information gathered
- helping pupils' thinking to progress.

The examples presented of teachers exploring pupils' skills, knowledge and understanding, while drawn from classroom activities in primary schools, demonstrate approaches which apply also in secondary schools.

Scottish Council for Research in Education
15 St John Street
Edinburgh EH8 8JR

ISBN 1 86003 002 5

BEST COPY AVAILABLE